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U.S. Army Toxic and Hazardous Materials Agency

TOOELE ARMY DEPOT
PRELIMINARY ASSESSMENT/SITE INVESTIGATION
FINAL REPORT

VOLUME II - SOUTH AREA

DECEMBER 1988

PREPARED FOR:

U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
INSTALLATION RESTORATION DIVISION
ABERDEEN PROVING GROUND, MARYLAND 21010-5401

BY:

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.
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FINAL REPORT

PRELIMINARY ASSESSMENT/SITE INVESTIGATION
TOOELE ARMY DEPOT, UTAH

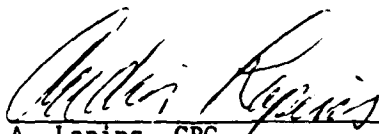
VOLUME II - SOUTH AREA

Prepared for

U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland 21010

Prepared by

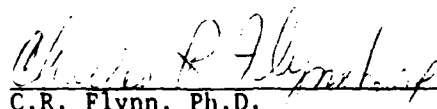
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19 ABSTRACT (Continue on reverse if necessary and identify by block number) <p>This report documents the Preliminary Assessment/Site Investigation (PA/SI) phase of the U.S. Army Installation Restoration Program for the South Area of Tooele Army Depot (S-TEAD), Utah. The PA/SI for S-TEAD involved the performance of a records search, and the development and implementation of a preliminary field sampling and analysis program. The objectives of the PA/SI were: (1) identify S-TEAD sites used to store, process, and/or dispose of hazardous waste; (2) determine which of these sites have a low potential for environmental contamination and/or pose no immediate apparent threat to public health and welfare; (3) determine which sites have a high potential for environmental contamination and/or pose a threat to public health and welfare; and (4) perform limited sampling of soil, groundwater, and/or surface water to determine the existence of contamination, if any, and to evaluate offsite migration potential.</p>			
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Following review of the available database and performance of an onsite visit, 17 sites were identified as potential sources of environmental contamination. Of those sites, 5 were determined to present a significant potential threat to the environment and/or public health and welfare: (1) the Bomb Washout Area at former Building 600, (2) the Laundry Effluent Ponds at abandoned Building No. S-3200, (3) the Explosion Craters located at the Old Demilitarization Range, (4) Diesel Fuel Spill/Leak Site at CAMDS, and (5) the Boiler Blowdown Wastewater Discharge south of CAMDS. The presence and distribution of arsenic in groundwater of S-TEAD (discovered during a prior project) were also investigated during the PA/SI. A field sampling and analysis program was developed to provide data to evaluate the existence of contamination at these sites and within groundwater at S-TEAD. The field investigation effort involved the installation of 4 monitoring wells, and the acquisition and analysis of samples of groundwater (from newly installed wells and existing wells throughout S-TEAD), surface water, and soil. Analyses were performed for volatile and semi-volatile organics, explosives, chemical agent breakdown products, metals, inorganics, and radionuclides.

Groundwater in the CAMDS facility was found to be heavily contaminated with diesel fuel and was determined to pose a potential fire and health hazard via seepage into below-grade structures. Explosives contamination was also discovered in the CAMDS monitoring well (CAM-3), a downgradient monitoring well (S-1), and an aqueous sample from the blowdown runoff, however, the source could not be determined with certainty. Explosives contamination was not found within surface soil of the Bomb Washout Pond and the Shower/Laundry Effluent Holding Pond. Analysis of surface water samples obtained from the two explosion craters located in the Old Demilitarization Range did not reveal any contamination which could be directly attributed to the activities conducted at this site. Explosive contamination was detected in monitoring Well S-6, located downgradient of the site of the Old Demilitarization Range. Explosive contamination was also detected in the upgradient monitoring Well SBR-1.

Arsenic, sodium, chloride, sulfate, and gross alpha and beta radionuclide activity were detected in all groundwater samples. Applicable Federal and Utah drinking water standards for these constituents were exceeded in samples obtained from wells generally located toward the valley bottom (south-southwest portion of S-TEAD). Available information suggested that the widespread presence and occurrence of these constituents may be due to naturally occurring sources.

Based on a review of available records, personnel interviews, and an onsite inspection, there was no indication that the release of toxic or hazardous materials to the environment had resulted from activities performed at the: (1) Sewage Lagoon, (2) South Area Lab, (3) Munitions Storage Areas 9 and 10, (4) Old Munitions Storage Area 2, (5) Warehouse C4002 Demilitarization Pit, (6) Active Sanitary Landfill, and (7) Abandoned Sanitary Landfill.

A moderate to high potential for the release of contaminants to the environment was also determined to exist at: (1) Mustard Holding Area, (2) Chemical Demilitarization Range Disposal Pits, (3) Windrow Area, (4) Gravel Pits, and (5) the Burial Pit. Sampling and analysis of soil and/or groundwater would be required to confirm the potential presence or absence of contamination at these sites. The existing monitoring well network was not considered adequate to assess the potential for environmental contamination at these sites. Results, conclusions, and recommendations are included in the report.

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LIST OF ABBREVIATIONS AND ACRONYMS

General

AEHA	Army Environmental Health Agency
AFSC	Air Force Systems Command
ALS	Above land surface
AMCR	Army Material Command Regulation
ASTM	American Society of Testing and Materials
BLS	Below land surface
BTC	Below top of casing
CAMDS	Chemical Agent Munition Disposal System
CE	U.S. Army Corps of Engineers
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CES	Civil Engineering Squadron
CGW	Chemistry Groundwater File
CRL	Certified Reporting Limit
CSO	Chemistry Soil File
DFAE	Directorate of Facilities Engineering
DMS	Data Management System
DOD	Department of Defense
DOT	Department of Transportation
DPDO	Defense Property Disposal Office
DPDS	Defense Property Disposal System
DRMO	Defense Reutilization Marketing Office
EPA	Environmental Protection Agency
EPIC	Environmental Photographic Information Center
GC	Gas chromatograph method of chemical analysis
GC/MS	Gas chromatograph/mass spectrometry
GFD	Geotechnical field drilling file
GGG	Geotechnical groundwater stabilization file
GMA	Geotechnical map location file
GWC	Geotechnical well construction file
GWQA	Groundwater Quality Assessment
HMTC	Hazardous Materials Technical Center
HX, HE	High Explosive
IRDMS	Installation Restoration Data Management System
ID	Inside diameter
IRP	Installation Restoration Program
LWC	Local wind circulation
MCL	Maximum contaminant level
MSL	Mean sea level
NCO	Non-commissioned officer
ND	Not detected
NPDES	National Pollutant Discharge Elimination System
N-TEAD	North Area - Tooele Army Depot
OD	Outside diameter
PA/RP	Plan of Accomplishment/Resource Plan
PA/SI	Preliminary Assessment/Site Investigation
PED	Production Engineering Division, Maintenance Directorate
POL	Petroleum, oil, and lubricant

LIST OF ABBREVIATIONS AND ACRONYMS (Cont.)

General

PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
SOP	Standard Operating Procedure
SR	State route
SS	Split spoon
S-TEAD	South Area - Tooele Army Depot
TDS	Total dissolved solids
TEAD	Tooele Army Depot
TOC	Total organic carbon
TOD	Tooele Ordnance depot
TOX	Total organic halogens
TSCA	Toxic Substance Control Act
USAEHA	U.S. Army Environmental Hygiene Agency
USAETL	U.S. Army Engineer Topographic Laboratories
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
USGS	U.S. Geological Survey
UXO	Unexploded ordnance
VOC	Volatile organic compounds
WP	White phosphorus

Units of Measure

°C	Degrees Celsius
°F	Degrees Farenheit
ft	Feet
ft/day	Feet per day
ft/sec	Feet per second
ft/year	Feet per year
gals	Gallons
gpd	Gallons per day
gpm	Gallons per minute
in.	Inches
km	Kilometers
m	Meters
MGD	Million gallons per day
mg	Milligrams
mg/liter	Milligrams per liter
ng	Nanograms
ng/liter	Nanograms per liter
ppb	Parts per billion
ppm	Parts per million
pCi/liter	Picocuries per liter
ug/liter	Micrograms per liter
umhos/cm	Microumhos per centimeter

LIST OF ABBREVIATIONS AND ACRONYMS (Cont.)

General

Chemicals

Ag	Silver
As	Arsenic
Ba	Barium
Ca	Calcium
CaCO ₃	Calcium carbonate
Cd	Cadmium
Cl	Chloride
CO ₃	Carbonate
Cn	Cyanide
Cr	Chromium
CTC	Carbon tetrachloride
Cu	Copper
DNB	Dinitrobenzene
DNT	Dinitrotoluene
Fe	Iron
HCL	Hydrochloric acid
Hg	Mercury
HMX	Octahydro-tetranito-tetrazocine
HNO ₃	Nitric acid
K	Potassium
Na	Sodium
Ni	Nickel
NO ₂	Nitrite nitrogen
NO ₃	Nitrate nitrogen
Pb	Lead
RDX	Cyclonite (high explosive primer)
Se	Selenium
TCA	1,1,1-trichloroethane
TCE	Trichloroethene (same as trichloroethylene)
TNT	Trinitrotoluene
Zn	Zinc

EXECUTIVE SUMMARY

EA Engineering, Science, and Technology, Inc. was contracted by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) to conduct a Preliminary Assessment/Site Investigation (PA/SI) of Tooele Army Depot, Utah, under Contract No. DAAA15-86-0002. USATHAMA has the mission of conducting the U.S. Army Installation Restoration Program. The objective of this program is to identify and eliminate or control the migration of contamination resulting from past operations throughout the Army and consists of three phases: PA/SI, Remedial Investigation/Feasibility Study (RI/FS), and Remedial Actions. The work accomplished under this contract constitutes the first phase.

The Tooele Army Depot (TEAD) consists of three physically separated facilities: the North Area, the South Area, and the TEAD Rail Shops at Hill Air Force Base. Volume II of this report addresses the South Area (S-TEAD) installation PA/SI. The North Area and the TEAD facilities at Hill Air Force Base are addressed in Volume I of this report.

S-TEAD is located in Tooele County, Utah and covers approximately 20,000 acres. S-TEAD, which began operating in 1943, is one of the major chemical ammunition storage and demilitarization installations in the continental United States. The primary missions of S-TEAD are the storage and maintenance of chemical munitions and demilitarization and surveillance of ammunition. The Chemical Agent Munitions Destruction System (CAMDS) is located in S-TEAD.

The TEAD PA/SI, initiated in September 1985, involved the performance of a records search and review, an onsite visit to inspect sites of interest and interview employees, and the development and implementation of a field sampling and analysis program. The objectives of the PA/SI were: (1) using the existing available database, identify sites at S-TEAD used to store, process, and/or dispose of hazardous waste; (2) determine which of these sites have a low potential for environmental contamination and/or pose no immediate apparent threat to public health and welfare; (3) determine which sites have a high potential for environmental contamination and/or pose a threat to public health and welfare; and (4) perform limited sampling of soil, groundwater, and/or surface water to determine existence of contamination, if any, and to evaluate potential for offsite migration. It was not the intent of this study to determine the extent of contamination, only to determine if contamination existed at a site. Contaminated sites would then be recommended for inclusion in the remedial investigation for the purpose of determining the horizontal and vertical extent of that contamination.

Following review of the available database and performance of the onsite visit, a Field Sampling Design Plan was prepared which described 17 S-TEAD sites identified as potential sources of environmental contamination. Of these sites, 5 were considered to present a significant potential threat to the environment and/or public health and welfare: (1) the Bomb Washout Area at former Building 600, (2) the Laundry Effluent Ponds at abandoned Building No. S-3200, (3) the Explosion Craters located at the Old Demilitarization Range, (4) Diesel Fuel Spill/Leak Site at CAMDS, and (5) the Boiler Blowdown Wastewater Discharge south of CAMDS. A field sampling and analysis program was

developed to provide data to evaluate the existence of contamination, if any, and to provide a preliminary assessment of the potential for contaminant migration, if appropriate. In addition to these specific sites, the overall quality of groundwater at S-TEAD was investigated.

The field effort at the CAMDS facility involved the installation of 3 groundwater monitoring wells at the Diesel Fuel Spill/Leak Site, and the acquisition and analysis of a groundwater sample and an aqueous sample from the Boiler Blowdown Wastewater discharge ditch south of CAMDS. The major findings of the PA/SI activities performed in the CAMDS Facility area are summarized as follows:

- . Groundwater in the vicinity of the Diesel Fuel Storage Tanks was found to be heavily contaminated with diesel fuel. Floating product was observed in two of the wells and chemical components of diesel fuel were detected in the third well.
- . The shallow groundwater table at the CAMDS facility requires the use of sump pumps in many of the below-grade structures. Therefore, a potential exists for floating product and/or diesel fuel contaminated groundwater seepage to occur into below-grade structures and result in a potential fire hazard, and/or health hazard via hazardous component exposure to employees working in these areas.
- . 2,4,6-TNT (14.2 µg/L) was detected in a groundwater sample and tetryl (5.6 µg/L) was detected in an aqueous sample obtained from the Boiler Blowdown Discharge Ditch. The source of the explosive compounds detected is anomalous and could not be determined with certainty from available information. The CAMDS Facility is relatively new and provides for full explosive containment. As such, a potential source and pathway could not be identified. However, the blowdown discharge sample contained a significant quantity of silt and it is possible that the explosives detected were due to their presence in soil from past activities at S-TEAD.

Based on these findings, it was recommended that soil borings be performed and additional monitoring wells be installed west of the Diesel Fuel Storage Tank Area to determine the extent of the diesel fuel plume and to verify the presence and extent of explosives contamination in soil and groundwater. It was further recommended that a sediment-free aqueous sample of the boiler blowdown discharge be obtained (prior to where it enters the drainage ditch) and that aqueous and sediment samples be obtained along the drainage ditch and ponding area to determine the source and extent of potential explosives contamination.

Analysis of a surficial soil sample obtained from the Bomb Washout Pond did not show the presence of any explosives above the certified reporting limit.

Analysis of a surficial soil sample obtained from the Shower/Laundry Effluent Holding Pond did not reveal any explosive contamination. There was no information which indicated that the activities conducted at this site resulted in environmental contamination.

Analysis of surface water samples obtained from two of the explosion craters located in the Old Demilitarization Range did not reveal any contamination which could be attributed to the activities conducted at this site.

In addition to the three previously mentioned sites, based on a review of available records, personnel interviews, and an onsite inspection:

- . There was no indication that the release of toxic or hazardous materials to the environment had resulted from activities performed at the following sites: (1) Sewage Lagoon, (2) South Area Lab, (3) Munitions Storage Areas 9 and 10, (4) Old Munitions Storage Area 2, (5) Warehouse C4002 Demilitarization Pit, (6) Active Sanitary Landfill, and (7) Abandoned Sanitary Landfill.
- . The release of contaminants to the environment had occurred, or had the potential to occur, at the following sites: (1) Mustard Holding Area, (2) Chemical Demilitarization Range Disposal Pits, (3) Windrow Area, (4) Gravel Pits, and (5) the Burial Pit. Sampling and analysis of soil and/or groundwater would be required to confirm the potential presence or absence of contamination at these sites. The existing monitoring well network was not considered adequate to assess the potential for environmental contamination which may or may not be emanating from these sites.

Groundwater samples were obtained from 11 existing monitoring wells and 2 newly installed wells, located throughout S-TEAD, in order to assess the overall quality of groundwater, and its relationship with individual sites, where possible. The major findings and conclusions are outlined below.

- . Toluene was the only volatile organic compound detected in groundwater, and was found in 5 of the 13 wells sampled (including upgradient Well SBR-1) at concentrations ranging from 3 to 10 µg/L. The source of the toluene contamination found is not known, as there was no documentation indicating that activities/operations practiced at S-TEAD would contribute this type of contamination. The level of toluene contamination found in the groundwater was not considered to present a significant environmental or public health risk.
- . Low concentrations of five semi-volatile compounds were detected in groundwater samples: butyl benzyl phthalate, bis(2-ethyl hexyl)phthalate, phenol, butyl benzyl alcohol, and 2-methyl phenol. The first two compounds are common

components of plastics, and their presence is believed to most likely be due to laboratory contamination. The source of the other three semi-volatiles was not known and could not be determined from the available database.

- . Chemical agent breakdown products were not detected in any of the groundwater samples.
- . An explosive compound was found above certified reporting levels in 4 groundwater samples. 2,4-DNT was detected in the samples from Well Nos. SBR-1 and S-6 at concentrations of 2.5 µg/L and 3.3 µg/L, respectively. 2,4,6-TNT was detected in the sample from CAM-3 at a concentration of 14.2 µg/L and 2,6-DNT was detected at concentration of 20.5 µg/L in a sample obtained from Well No. S-1. The source of the explosive compound contamination detected in upgradient Well SBR-1 is not known and could not be determined from the available database. The explosive contamination found in S-6 is likely due to the demilitarization activities conducted in the Old Demilitarization Range. Contaminated soil was determined to be the likely source of the explosive detected in CAM-3 and S-1.
- . Chromium was detected in a groundwater sample obtained from Well No. S-10 at a concentration of 88 µg/L. The Federal and Utah drinking water standard for chromium is 50 µg/L. However, total metals analysis was performed and the concentration of dissolved metals would be anticipated to be less. The source of the elevated chromium level detected in the sample obtained from this well is not known and could not be determined from the available database.
- . Concentrations of nitrate+nitrite nitrogen ranging from .11 to 4.5 mg/L were below the Federal and State drinking water standards for nitrates (10 ppm).
- . Arsenic, sodium, chloride, sulfate, and gross alpha and beta radionuclide activity were detected in all groundwater samples. Applicable Federal and Utah drinking water standards for these constituents were often exceeded in samples obtained from wells which are generally located toward the valley bottom (south-southwest portion of S-TEAD). A general increasing concentration trend toward the valley bottom was also evident. The widespread presence and occurrence of these constituents in groundwater at S-TEAD suggests that they may be naturally occurring.
- . Whether an individual site, or the degree to which an individual site, may or may not be contributing to the contamination of groundwater at S-TEAD could not be determined due to the natural occurrence of many of the constituents of concern and the absence of both upgradient and downgradient monitoring wells in their close proximity.

- . Based on the present monitoring well network, the quality of groundwater at S-TEAD was not considered to present an immediate risk to the health or welfare of the public as there is no indication that off-depot contaminant migration has occurred, and there are no downgradient water supply wells in the immediate vicinity of S-TEAD which could be impacted. However, due to the limited number of wells covering such a large area, the monitoring well network can only give limited groundwater quality data in a gross groundwater flow information.

In order to better determine the presence or absence of contamination at individual sites and the potential for offsite and off-Depot contaminant migration, it was recommended that additional monitoring wells be installed in the southeastern, southwestern, and northwestern perimeter area of S-TEAD and to conduct aquifer testing on selected wells, such that potential travel times and distances for individual sites and the depot could be evaluated. It was also recommended that soils in the former Mustard Holding Area be sampled and analyzed to determine the presence/ absence of contamination in this area.

1. INTRODUCTION

1.1 SITE BACKGROUND

1.1.1 Location

The Tooele Army Depot (TEAD) is located in North Central Utah. The TEAD Complex consists of three physically separated areas: South Area, North Area, and Hill Air Force Base Rail Shops. The general location of the TEAD complex is shown on Figure 1-1. Figure 1-2 is an area map of the TEAD South Area (S-TEAD).

S-TEAD is located approximately 15 miles south of the North Area (the administrative headquarters of the TEAD complex). S-TEAD is situated in Rush Valley and is bounded on the west by the Stansbury Mountains, on the east by the Oquirrh Mountains, and on the north by South Mountain. The Sheep Rock and West Tintic mountains are to the south. S-TEAD comprises an area of approximately 19,364 acres.

The area surrounding S-TEAD is a sparsely settled, rural area. Population density is approximately three persons per square mile in the valley, with nearly the entire population concentrated in a few communities. The closest town is Stockton (1980 population: 522) located about 10 miles north of S-TEAD (Tooele Army Depot 1985a).

1.1.2 Installation History

The Tooele Ordnance Depot was established 7 April 1942 by the Army Ordnance Department. Construction of the facilities, including igloos, magazines, administration buildings, military and civilian housing, roads, hardstands for vehicle storage, and other allied appurtenances, was completed in January 1943.

During the construction, the Defense Department also ordered construction of a storage depot for Chemical Corps toxics at the location of S-TEAD. This facility was named the Deseret Chemical Warfare Depot. The storage facility included 140 igloos, 2 magazines, 7 warehouses, 32 toxics sheds, and several transitory storage shelters.

In May 1955, Deseret Chemical Depot was redesignated the Deseret Depot Activity and placed under the command of TEAD. The Depot Activity was discontinued in 1962, at which time the installation became part of the Tooele Ordnance Depot and was designated as the South Area.

The Tooele Ordnance Depot was redesignated Tooele Army Depot in August 1962. Since that time, TEAD's mission has been gradually altered and expanded to include support of other Army installations throughout the western United States. Today, the Tooele Army Depot is one of the major ammunition storage and equipment maintenance installations in the continental United States.

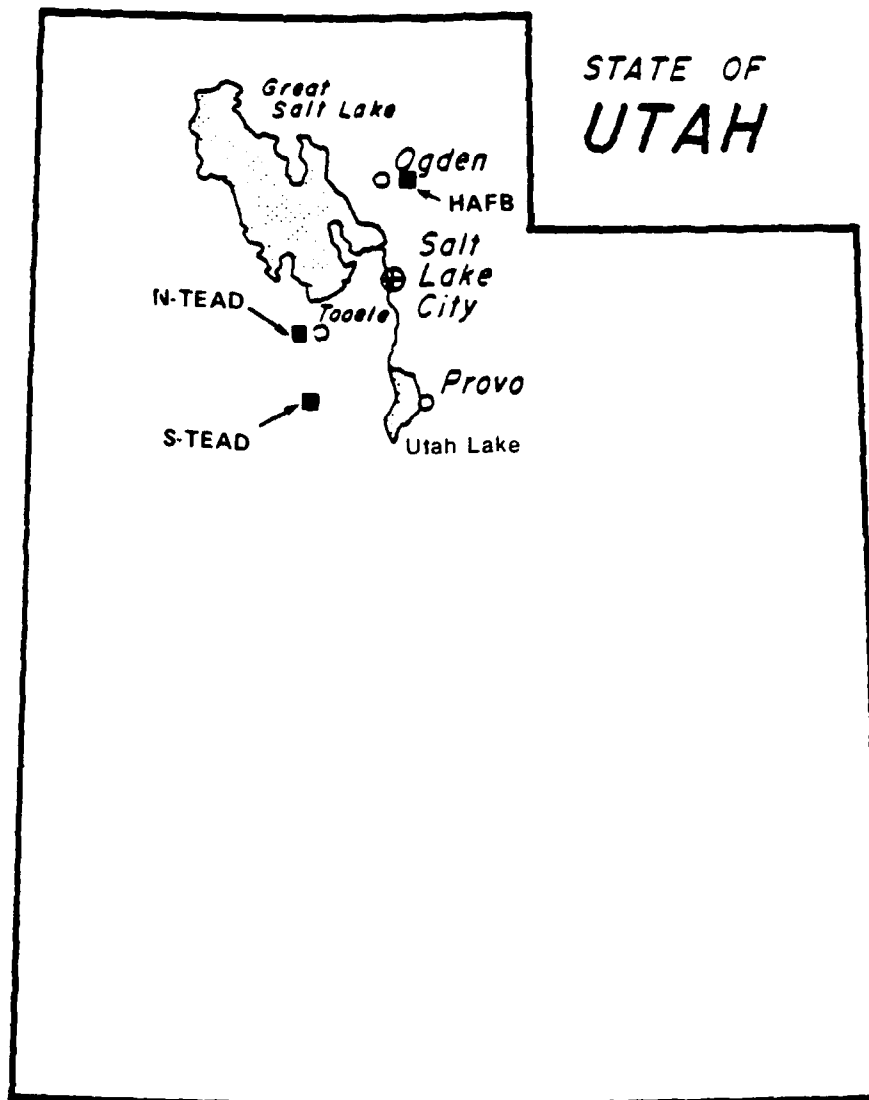
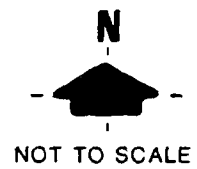


Figure 1-1. General location map of the Tooele Army Depot Complex.

Source: U.S. Army, 1982

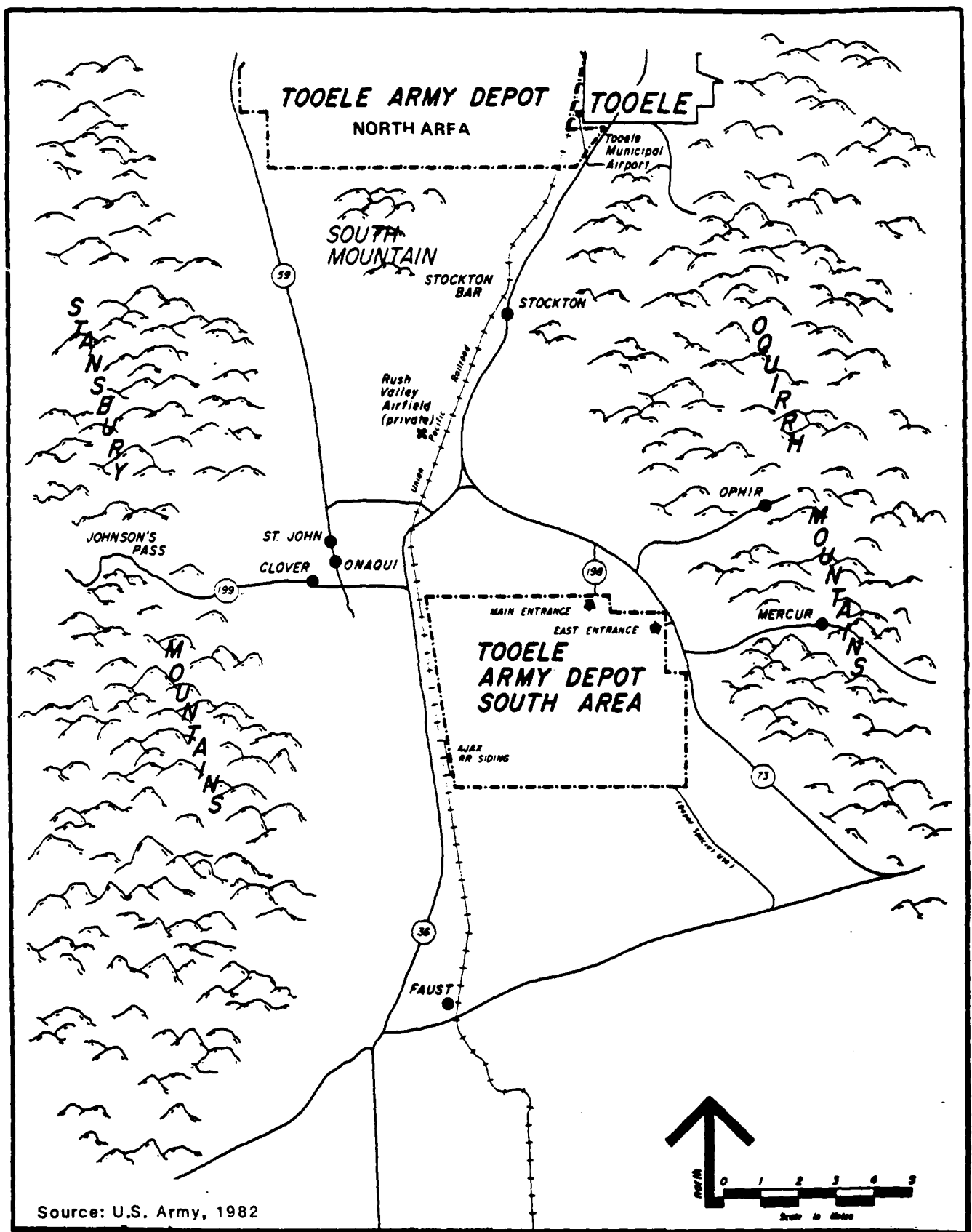


Figure 1-2. Area map of S-TEAD.

The Chemical Agent Munitions Disposal System (CAMDS) was designed and built in 1979 in the South Area. This facility designs and tests processes and equipment to demilitarize and detoxify chemical munitions (Tooele Army Depot 1985b; USATHAMA 1979).

1.1.3 Installation Mission and Activities

The mission of the Tooele Army Depot is to (1) provide for the receipt, storage, issue, maintenance, and disposal of assigned commodities; (2) provide installation support to attached organizations; and (3) operate other facilities as may be assigned. The primary mission of S-TEAD is the storage and maintenance of chemical munitions, and demilitarization and surveillance of ammunition.

The CAMDS Facility is located in S-TEAD and currently employs 205 personnel. CAMDS is responsible for the piloting and testing of new and unique demilitarization processes, as well as the maintenance of the CAMDS Facility, which is the dominant operation in the South Area. The CAMDS Facility handles large volumes of hazardous chemicals. CAMDS is currently processing agent GB (Tooele Army Depot 1985b; USATHAMA 1979).

1.2 PRELIMINARY ASSESSMENT/SITE INVESTIGATION OBJECTIVES

The overall objectives of the Preliminary Assessment/Site Investigation (PA/SI) were (1) using the existing available database, identify S-TEAD sites used to store, process, and/or dispose of hazardous waste; (2) determine which of these sites have a low potential for environmental contamination and/or pose no immediate apparent threat to public health and welfare; (3) determine which sites have a high potential for environmental contamination and/or pose a threat to public health and welfare; and (4) perform limited sampling of soil, groundwater, and/or surface water to determine existence of contamination, if any, and to evaluate potential for offsite migration. PA/SI tasks were separated into pre-onsite and onsite work and are detailed below. Table 1-1 provides a summary of the tasks, deliverables, and schedule for the S-TEAD PA/SI program.

1.2.1 Pre-Onsite Work

The first task to be performed under this phase of the PA/SI was to prepare a Plan of Accomplishment/Resource Plan (PA/RP) detailing the objectives, work schedule, and budget for the project (EA 1985). The draft PA/RP was submitted to USATHAMA on 7 October 1985 for comments. The final PA/RP was submitted on 11 November 1985.

The second task was to retrieve and review all available documents for information on installation operations, waste treatment and disposal practices, known or suspected sites of contamination, previous and ongoing contamination assessment investigations, and environmental settings. Documents reviewed during this phase of the project were provided by USATHAMA.

TABLE 1-1 SUMMARY OF PROJECT TASKS AND DELIVERABLES FOR THE S-TEAD
PA/SI PROGRAM

Task/Deliverable	Date(s)
Project Initiation	September 1985
Plan of Accomplishment/Resource Plan	
--Draft	7 October 1985
--Final	11 November 1985
Pre-Onsite Briefing	20 November 1985
Onsite Visit	9-13 December 1985
Field Sampling Design Plan/Health and Safety Plan	
--Draft	20 January 1986
--Final Draft	6 March 1986
--Final	6 June 1986
Sampling Design Plan Briefing	14 February 1986
Predrilling Site Visit	19-23 May 1986
Well Installation Field Program	30 June - 31 July 1986
Sampling/Analysis Field Program	17 February - 4 March 1987
Installation PA/SI Report	
--Draft	15 June 1987
--Final Draft	February 1988
--Final	December 1988

A pre-onsite briefing with EA and USATHAMA personnel was conducted at the Aberdeen Proving Ground, 20 November 1985. The purpose of this briefing was to discuss onsite work objectives.

1.2.2 Onsite Work

An onsite visit was conducted at S-TEAD by EA during the week of 9-13 December 1985. The purpose of this visit was to interview installation personnel, review installation documents, and visit areas of interest identified during pre-onsite work. A large part of the onsite visit was spent conducting interviews and visiting specific sites. TEAD personnel, not available during the onsite visit, were interviewed over the telephone at a later time. Due to the access restrictions, the only site in the south that could be inspected by foot was the CAMDS facility. However, a helicopter overflight of S-TEAD was conducted during the onsite visit. This helped in obtaining an overview of the installation and provided an opportunity to see some areas which were not otherwise accessible.

The following issues and topics were addressed during the onsite visit:

- . CAMDS facility
- . Sanitary landfills
- . Demolition areas (chemical and conventional munitions)
- . Water supply and treatment/wastewater treatment
- . Washout ponds
- . Chemical munitions storage Areas 2, 9, and 10
- . Windrow area
- . Site ecology

The scope of work for the field program was developed using information and data obtained from the records search, Depot employee interviews, and site visits. A draft Field Sampling Design Plan was submitted to USATHAMA on 20 January 1986. EA conducted a formal briefing on the Sampling Design Plan to USATHAMA on 14 February 1986. During this briefing, USATHAMA approved EA's proposed scope of work for some of the sites and made changes to the proposed scope of work at other sites. The final Field Sampling Design Plan/Health and Safety Plan was submitted to USATHAMA on 6 June 1986 (EA 1986).

A Predrilling Site Visit was conducted during 19-23 May 1986 to obtain water level measurements on existing monitoring wells, clear and stake well boring locations, and to discuss and coordinate the well drilling program with TEAD personnel. The Well Installation/Development Program was conducted during the period of 30 June - 31 July 1986. Delayed laboratory certification extended the Field Sampling Program until the period from 17 February to 5 March 1987.

1.3 OVERVIEW OF REPORT

The remaining chapters of this report (Volume II) address the following topics: site features, local and regional physiography, waste sources

and disposal/treatment methods, findings of other environmental investigations, development and implementation of the field program, and results and findings of the field program.

Chapter 2, Site Features, summarizes the cultural resources (demography, land use, historical and archaeological sites), natural resources (flora and fauna), and climate of the area in and around S-TEAD.

Chapter 3, Physiography, discusses the local and regional geology, hydrogeology, soils, and surface waters. Information presented in Chapters 2 and 3 was obtained from existing available records and from implementation of the field program.

Chapter 4, Hazardous Substances Characterization, briefly describes S-TEAD waste sources and waste disposal/treatment methods employed at the Depot.

Chapter 5, Summary and Findings of Other Environmental Investigations, provides a summary of the findings, conclusions, and recommendations of other environmental studies conducted at S-TEAD. This chapter addresses only those investigations which have involved extensive record searches and/or sampling and analysis.

The objective of Chapter 6, Preliminary Site Investigations, was to present background information specific to all sites identified as potential sources of contamination. Information obtained from existing available records and from the onsite visits is presented in this chapter.

In Chapter 7, Field Program, the development and implementation of the Installation Reassessment Field Program (well installation and sampling and analysis programs) are described. Also addressed in this chapter are changes in the field program (well installation and sampling analysis) that were made following development of the Field Sampling Design Plan.

Chapter 8, Environmental Contamination Investigations, presents a detailed discussion of the data results obtained during field investigations conducted for this installation PA/SI. At S-TEAD, the investigation focused on five specific sites: (1) CAMDS Diesel Fuel Spill Site (2) CAMDS Boiler Blowdown Wastewater Discharge Site, (3) Explosions Craters, (4) Bomb Washout Pond, (5) Laundry Effluent Pond, and (6) the overall quality of groundwater at S-TEAD. Chapter 8 also presents background information on site characteristics (soil, groundwater, surface water, topography) important to understanding contaminant transport and potential environmental and public health impacts.

Conclusions and Recommendations based on the findings of this investigation are presented in Chapters 9 and 10, respectively. A list of references follow Chapter 10. The appendixes for the S-TEAD report are provided as a separate document.

1.4 ACKNOWLEDGEMENTS

The authors wish to express their appreciation to Ms. Mary Ellen Heppner and Mr. John Sanda of USATHAMA for assistance with the organizational and technical portions of this report, and to Mr. Andrew W. Anderson of USATHAMA for his aid in communications and interaction between Depot personnel and consultants.

The authors also acknowledge the cooperation and assistance provided throughout the project by Mr. Robert O'Conner and Mr. Larry Fisher of the Tooele Army Depot, whose knowledge of the Depot greatly aided our study.

2. SITE FEATURES

2.1 CULTURAL RESOURCES

2.1.1 Demography

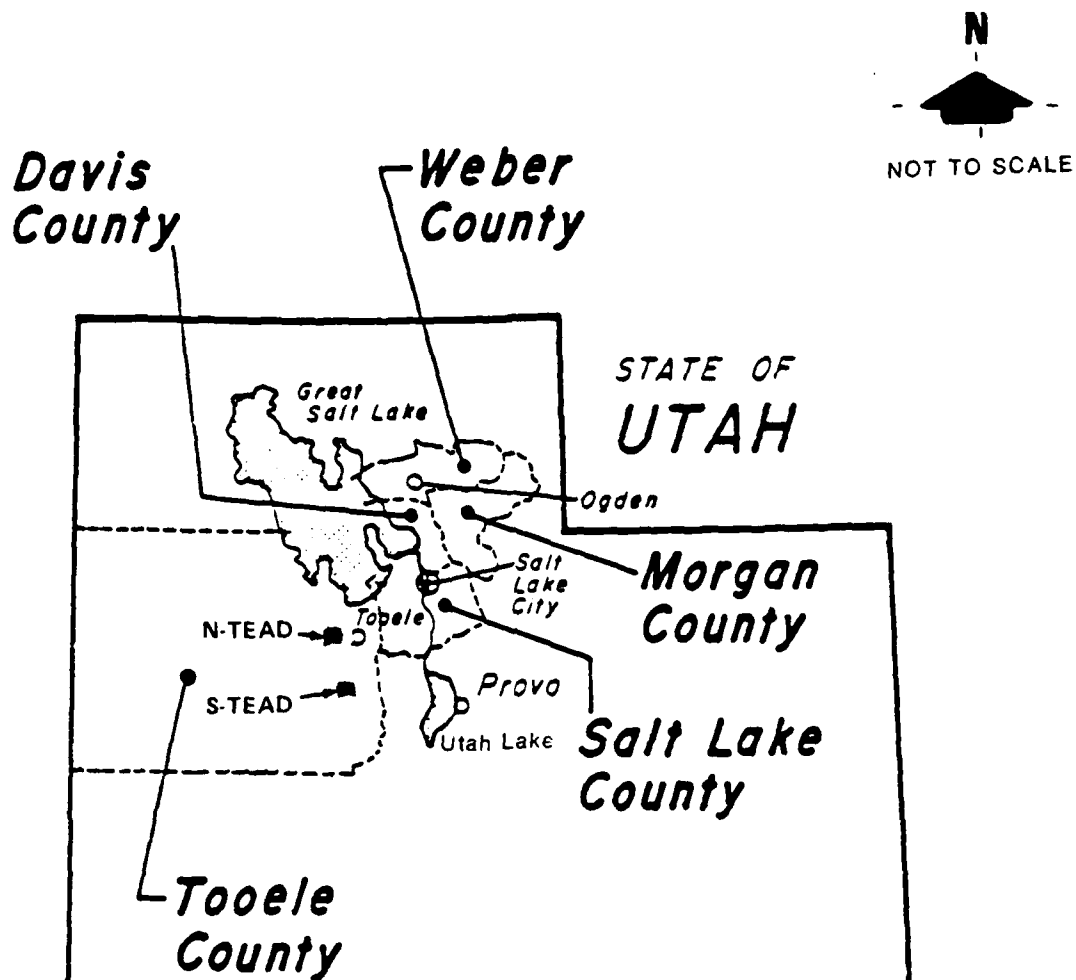
S-TEAD is located in Tooele County and is one of five counties comprising the Wasatch Front Multi-County Planning District (Figure 2-1). The other counties in this district are Davis, Morgan, Salt Lake, and Weber. The Wasatch Front District, the most populous and urbanized district in the State, contained 67 percent of the State's population in 1970 and 64.7 percent in 1980. Between 1970 and 1980, this District grew by 32.7 percent, while the rest of the State grew by 48.6 percent. The District's growth was negatively impacted by population declines in the cities of Salt Lake and Ogden. At the same time, smaller cities and unincorporated areas to the south and east of Salt Lake City, outside the Wasatch Front District, grew at rates of 50 percent or more in many cases.

Tooele County, west of Salt Lake City, exhibited a slower growth rate than most other Wasatch Front counties. Population growth in Tooele County has been subject to major fluctuation, reflecting mining and military activities conducted in the area. From 1950 to 1970, the total County population increased 47.2 percent, from 14,636 to 21,545.

The greatest portion of population increases occurred in three distinct time periods: 1950-1952, 1961-1963, and 1965-1968. These were related directly to government military employment connected with war activity in Korea and Vietnam. The lack of significant employment generators and the arid nature of this county have prevented large population concentrations. In addition, the heavy federal ownership of land in this part of the State reduces the acreage available for private development. There are signs, however, that given the right conditions, bedroom-type communities could develop in Tooele County servicing Salt Lake City.

Within Tooele County, growth was concentrated in areas along highway Interstate 80 and in proximity to N-TEAD. Cities in these areas, such as Tooele and Grantsville, had positive growth, while the more southern areas of Stockton, Rush Valley, and Ophir experienced a definite population loss. A profile of growth within Tooele County is provided in Table 2-1.

The population of the surrounding area, primarily Tooele County, has increased approximately 20.8 percent during the period 1970-1980, while Tooele City has experienced an 14.3 percent increase, according to preliminary 1980 census figures. Since 1980, population growth in Tooele County has practically ceased, primarily as a result of drastic cutbacks in the mining industries locally. During this period, Anaconda dropped from a workforce of 700+ to a caretaker force of less than 20. Kennecott Copper has reduced from a 7,000+ workforce to a small caretaker contingent and the Mercur gold mine operation has changed hands several times and is reducing its scope of operations. The Tooele County Master Plan predicts a 60 percent increase in County population by 1990 (U.S. Army 1982; Tooele Army Depot 1985a).



Source: U.S. Army, 1982

Figure 2-1. Wasatch Front Multi-County Planning District.

TABLE 2-1 POPULATION IN TOOELE COUNTY, 1970-1980

	<u>1970</u>	<u>1980</u>	<u>% Change</u>
Tooele County	21,545	26,033	20.8
Unincorporated areas	4,208	5,164	22.7
Incorporated areas	17,337	20,869	20.4
Tooele City	12,539	14,335	14.3
Grantsville City	2,931	4,419	50.8
Stockton Town	469	437	-6.8
Rush Valley Town	541	356	-34.2
Vernon Town	NA	181	--
Ophir Town	76	42	-44.7

Source: U.S. Department of Commerce, Bureau of Census,
1980 Census of Population and Housing; March 1981.

2.1.2 Land Use

S-TEAD is located in Rush Valley approximately 15 miles directly south of the main Depot complex at N-TEAD. The area between N-TEAD and S-TEAD is sparsely populated and consists of cultivated land along the valley floor west of State Route 36, range land grazing, scattered ranches, and the community of Stockton. The communities of St. John, Onaqui, and Clover are approximately 2 miles northwest of S-TEAD. Faust is located approximately 5 miles south, and Ophir is located approximately 4 miles northeast of S-TEAD. The ghost town of Mercur is roughly 3-1/2 miles to the east. The Mercur area has recently been purchased by Getty Oil and is planned for a minerals extraction and processing facility. Aside from these residential communities, the area surrounding the S-TEAD is undeveloped and used for rangeland grazing. The nearest residence is a ranch located within 1 mile of the northeast corner of S-TEAD. A Union Pacific Railroad right-of-way forms the western boundary of S-TEAD and has a siding or interchange yard along the northern half of the boundary.

The entire area surrounding S-TEAD is zoned MU-40. The MU-40, or Multiple Use District Zone, is intended as a low-density zone with limited human habitation and public utility and service requirements. The primary uses are agricultural and open space. The minimum parcel size per dwelling unit is 40 acres. Figure 2-2 is a zoning map for Tooele County and S-TEAD. The MU-40 zone essentially extends all the way to N-TEAD; the exceptions are two areas zoned A-20, immediately southwest of Stockton (U.S. Army 1982).

Land use and activity areas on S-TEAD are shown on Figure 2-3. Table 2-2 lists these land uses and the approximate acreage associated with each. The following discussion briefly outlines the activities which take place within these land use areas.

The open storage and ammunition area is located in the central portion of the Depot and is the largest of the identified land use areas. It consists of open pad storage, warehouses, and off-load facilities. Rail and truck access is provided to the area. The use intensity is relatively low and the southwestern portion of the area is undeveloped.

The igloo toxic storage area is located adjacent to the northwestern portion of the open storage and ammunition area. There are 140 igloos which are reinforced-concrete standard construction magazines and 68 recently-constructed igloos which are steel arch magazines located in this area. All igloos are earth-covered. Rail and truck also serve this area. The concrete igloos account for approximately 300,000 square feet of storage area, and the newly constructed steel arch igloos account for approximately 150,000 square feet.

The toxic storage area is located in the southeast corner of the open storage and ammunition area. The 32 storage structures in this area are served by a rail and street system.

The CAMDS area is located south of the the igloo area and open storage areas in the west-central portion of the Depot. The CAMDS facility is used for demilitarization of chemical munitions and storage containers

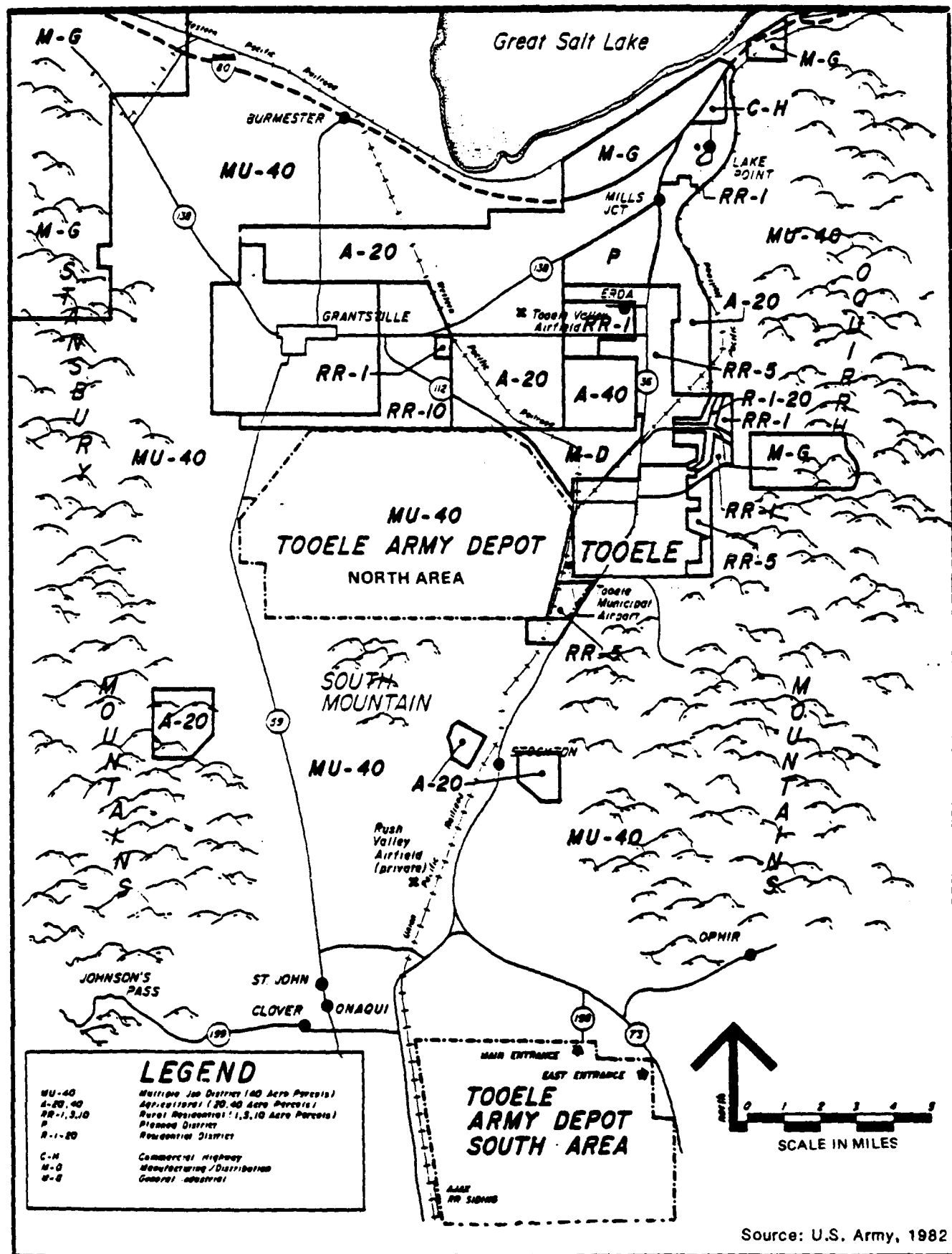
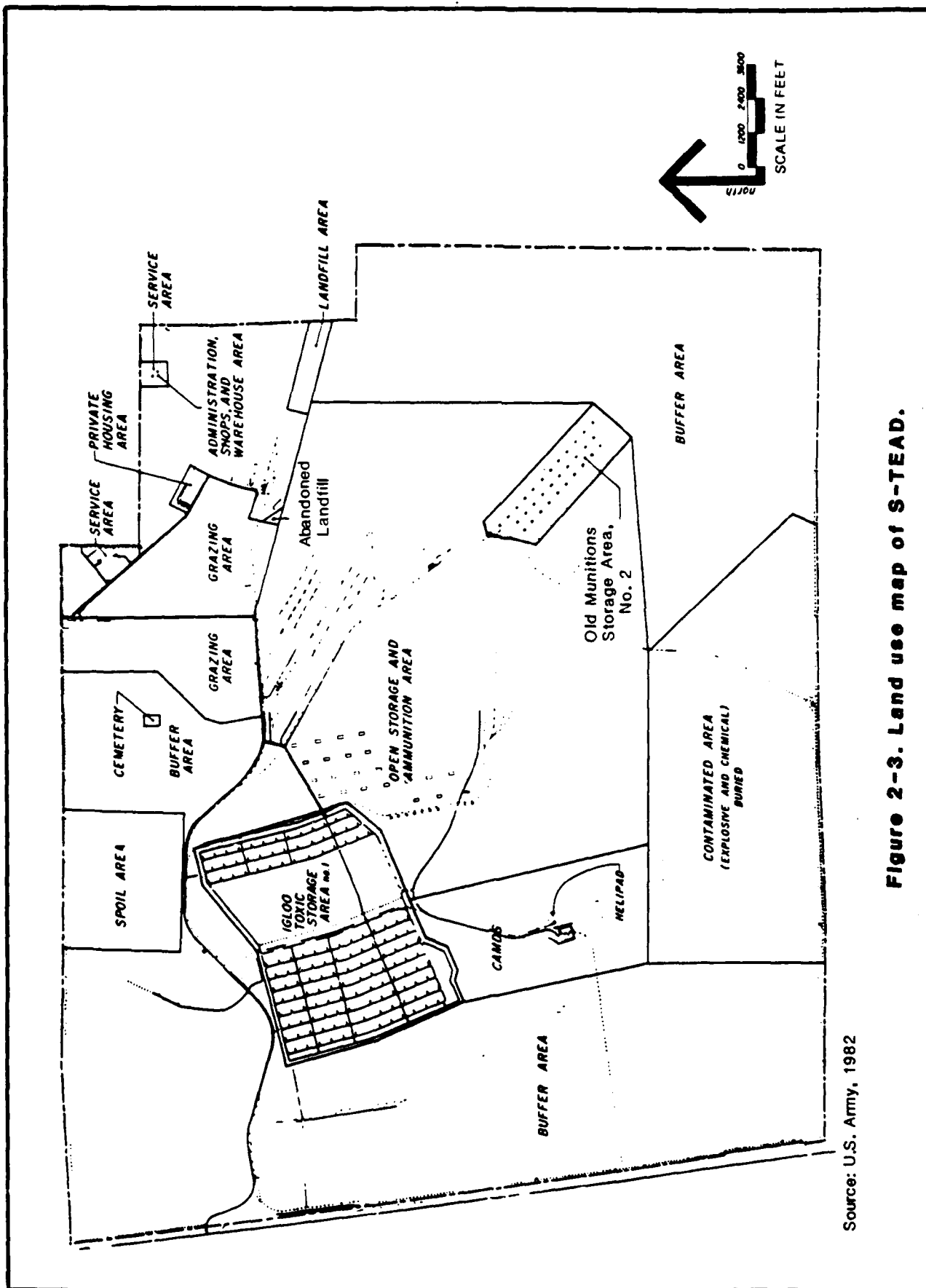


Figure 2-2. Tooele County zoning map.



Source: U.S. Army, 1982

Figure 2-3. Land use map of S-TEAD.

TABLE 2-2 LAND USES ON S-TEAD

Use	Acreage
Open storage and ammunition area	4,348
Igloo toxic storage area	1,151
Old munitions storage area	235
Camps area	700
Contaminated area (buried explosives and chemicals)	1,934
Spoil area	443
Landfill area	54
Abandoned landfill area	7
Administration, shops, and warehouse area	755
Service areas	54
Private housing area	26
Grazing areas	830
Buffer areas	8,822
Cemetery	5
Total	19,364

Source: U.S. Army 1982.

and the detoxification of nerve agents and mustard agent fills. This activity is a complex of structures enclosed within a 10-acre fenced site. With the exception of a newly constructed structure outside of the fence to the south and the facility itself, the CAMDS use area is undeveloped. The facility is served by rail and street access. A helipad is located adjacent to the east of the perimeter fence.

The contaminated area (buried explosives and chemicals) is located between the CAMDS facility, the open storage and ammunition area, and the southern Depot perimeter fence. This area consists of former demolition and burying areas, mustard holding areas, a mortar pit, and numerous other covered pits.

The spoil area is located along the central portion of the northern boundary of the Depot. It is a repository for excess and unsuitable soil material.

The existing landfill area is located southeast of the administration and warehouse area. It is used for disposal of general sanitary waste materials.

The abandoned landfill area is located southwest of the administration and warehouse area.

The administration, shops, and warehouse area is located in the northeast corner of the Depot. Aside from CAMDS, this is the major activity area on S-TEAD. The developed portion of the area is located in its southwestern corner, with the remainder being essentially undeveloped. This area contains warehouses, a dispensary, administrative facilities, a fire station, other personnel support facilities, a boiler plant, and maintenance facilities. The administrative, warehousing, and maintenance functions contained in this area are on a considerably smaller scale than those at N-TEAD.

Service areas are located within the northwestern portions of S-TEAD and to the northwest of the administrative, shops, and warehouse area. They consist of wells and reservoir sites.

The private housing area, located in the northeast portion of S-TEAD, consists of 26 units (13 structures) of privately-owned housing. This housing is the remaining portion of government-constructed wherry housing that was sold to private ownership.

The grazing areas are located north of the open storage and ammunition area and west of the administration area. This land is undeveloped and is leased to private individuals for cattle grazing.

Buffer areas, which make up the greatest acreage on S-TEAD, are located along the eastern, southern, western, and northern boundaries of the Depot. They are essentially non-use areas intended to buffer the munitions storage and activity areas. A firing range is located in the north buffer area, south of the cemetery. It is currently closed and has deteriorated to the point that it is unusable.

The cemetery is located in the north-central portion of the Depot. It is fenced, sterilized, and graveled.

2.1.3 Historical and Archaeological Resources

The history of Rush Valley is similar to that of Tooele Valley. Tooele Valley and Rush Valley have supported four separate Indian cultures. The Early Desert Archaic culture inhabited the area some 11,000 years ago, followed by the Late Desert Archaic, Fremont, and Numic-speaking cultures. The late Desert Archaic culture (3600 B.C. to 600 B.C.) moved upland when the marshy areas around Lake Bonneville dried up and the lake receded. Their stone tools and artifacts are believed to have been the same as those used by the Early Desert Archaics.

The Numic-speaking culture (Shoshones) was the last Indian culture in the vicinity. This tribe appeared 100-200 years before the Fremont culture disappeared. The Numic-speaking culture, which was a more nomadic hunting culture than the Fremont peoples, adapted to the increased aridity and still live nearby on the Coshute Reservation and the Skull Valley Indian Reservation.

Rush Valley was settled by Mormon ranchers and farmers in the 1850s and the valley supported large herds of livestock, including Texas Longhorns and sheep. The first families located at Settlement Canyon Creek near the City of Tooele. Tooele officially became a county on 31 January 1850, and the County Seat rotated among Tooele, Richville (present Mill Pond area), and Grantsville until 1867 when a Court House and a County Seat were permanently located in Tooele City. The valley continued to be used for grazing, and in 1869, when the first railroad entered the valley, agriculture became a major industry. Heavy use of the valley led to overgrazing; and within 30 years from the arrival of the first settlers, major portions of Tooele County constituted a dust bowl. Farming played a major role in the earlier days of settlement, but its importance diminished rapidly after the agricultural depression in 1930-1935.

Mining began in the area around 1859 and has played a major economic and environmental role ever since. The population of miners has varied throughout the years, dependent upon demand and new discoveries. This has resulted in a creation of several "ghost towns" in the area.

There are 43 "potential" historic sites in Tooele County including old trails, cemeteries, Pony Express stations, mills, and ghost towns. A historic cemetery is located in S-TEAD near the north central boundary (U.S. Army 1982; Tooele Army Depot 1985a).

2.2 **NATURAL RESOURCES**

2.2.1 Flora

The climate of Rush Valley profoundly influences the flora in the vicinity of S-TEAD. The lack of precipitation during the growing season is the major factor in the type of species, number of individuals, and

general productivity of the area. Plants have developed three adaptations to deal with the summer drought: drought resistance, tolerance, and avoidance. Plants have also adapted to a moderately eroded soil, and some have adapted to alkaline soils.

S-TEAD is classified as an *Artemisia* Biome characterized by sagebrush and saltbrush. Most of the area around the base consists of shadscale/big sagebrush habitat. The dominant species varies, but both species are usually present. Some variety occurs in the associated species, which include saltgrass, crested wheatgrass, squirrel tail grass, Indian ricegrass, and cheatgrass. In the northwestern part of the area, yellow brush is also associated.

On the valley floor near the southwestern corner of S-TEAD, vegetation is made up of alkaline-tolerant species: alkali sacaton, greasewood, nuttail saltbrush, and big rabbitbrush. Phreatophytes also do well as the groundwater level is relatively close to the surface.

The outwash of Mercur Creek provides a more restrictive setting for vegetation; it contains a brown-red soil that consists mainly of mine tailings. Metals present in the tailings inhibit vegetative growth. The Ophir Creek area and parts of its wash have another type of floral community. Vegetation along these strips is not dwarfed (sagebrush reaches 8 feet instead of 20 inches). Some small poplars and willows grow in this area (U.S. Army 1982). Figure 2-4 shows the floral community zones of S-TEAD.

2.2.2 Fauna

The condensed growth and reproduction of the plant communities in Rush Valley limits the ecological niches available to animal species. Not only is competition for food sources severe during the hot, dry summer and winter dormancy periods, but the animals must adapt to the same climatic conditions. They have adapted as hibernators, estivators, diurnals, or nocturnals, or have physiological adaptations that enable them to survive drought and heat, or cold and snow.

The vicinity of S-TEAD is inhabited by a wide variety of animal species ranging from protozoans to mammals, including 20 species of parasitic flatworms; 79 species of free-living, soil-inhabiting, or parasitic roundworms; 36 species of slugs and snails; 150 species of mites, ticks, spiders, pseudoscorpions, solpugids, and scorpions; 1,300 (and probably many more) species of insects; one species of amphibian; 6 species of lizard; 2 species of snake; 69 species of migrant birds; 11 species of winter resident birds; 71 species of summer resident birds; 63 species of birds in permanent residence; and 40 species of mammals.

Several species of game animals exist in the vicinity of S-TEAD. Mule deer, mountain cottontail, and desert cottontail inhabit the area. Fur-bearing animals include coyote and bobcat. Game birds include sage grouse, Gambel's quail, short-tailed grouse, blue grouse, ruffed grouse, and the imported ring-necked pheasant and chukar. In addition to the local game birds, there are 37 species of migratory waterfowl that use the flyways through the Depot.

Several species have been eliminated from the areas, including bison, gizzly bear, elk, black bear, pronghorned antelope, and mountain sheep. The mountain sheep, pronghorned antelope, and elk have been or are being reintroduced, mainly in the mountains.

There are 603 verified species of vertebrate wildlife in Utah. Of these, 507 are protected by the Division of Wildlife Resources of the Utah State Department of Natural Resources, including all birds, fish, amphibians, reptiles, and 29 mammals. Off-base hunting is permitted for all 57 game species (in season) and population control is largely due to hunter pressure. Management is achieved by varying the length of the season, the number of licenses, and limits. The Division of Wildlife Resources participates in range rehabilitation; studies the effects on wildlife of livestock grazing; stocks streams, ponds, and reservoirs with adapted fish; constructs desert mountain guzzlers; releases chukars and Hungarian partridge in adapted areas; develops waterfowl management areas; and surveys game. The Division of Wildlife Resources also regulates trapping under Section 23-13-2(28) of the Utah Code Annotated, as amended.

Two threatened or endangered species are known to be in the vicinity of S-TEAD: the bald eagle and the peregrine falcon. Bald eagle habitat in the area is considered critical, encompassing an extensive area in Utah including the Depot. The area needed by the bald eagle to roost, hunt, behave normally without disruption, and provide shelter is relatively large and encompasses many smaller habitats. Bald eagles are protected by United States Code 16, Section 668-668d.

Peregrine falcons have been sighted in the area. The range of peregrine falcons has been shrinking due to housing and agricultural pressure. Its prey is being depleted by the use of pesticides and rodenticides. Peregrine falcons are protected by the Endangered Species Act.

Zoonotic (transmittable from animals to man) diseases reported in the area are tularemia, rabies, Rocky Mountain spotted fever, Q fever, brucellosis, encephalomyelitis, plague, psittacosis, Anthrax, and hyated disease. The instance of disease in the area is lower than in most of the country, probably due to climate and elevation. Tularemia is an exception; one of the world's epicenters for tularemia is Delta, Utah. There was an outbreak in Grantsville and Delta in 1970 (U.S. Army 1982). Figure 2-4 shows the dominant animal species in each general habitat of S-TEAD.

2.3 CLIMATE

Rush Valley is characterized by hot, dry summers, cool springs and falls, moderately cold winters, and a general year-round lack of precipitation. The higher elevations of the adjacent mountains experience greater amounts of precipitation and somewhat cooler temperatures.

Most precipitation occurs as snow between early fall and late spring, when the Valley is affected by the continental winter storm track. Summers are generally dry, but showers and thunderstorms occur occasionally. The largest amount of precipitation occurs in the mountains, creating a potential for flash floods and erosion. Figure 2-5 illustrates precipitation and prevailing winds for the area around S TEAD.

Low humidity is a characteristic of the valley climate and visibility is generally good. During winter months, however, storm fronts are usually followed by high pressure fronts occasionally lasting for several weeks. These fronts trap the cold air in the Valley, creating temperature inversions which can create significant fog and smog problems.

The Salt Lake Basin forms a large, generally enclosed air basin of 7,500 square miles. The Great Salt Lake is a shallow body of water covering approximately 2,000 square miles, which is large enough to drive a classical sea-breeze circulation. The sea-breeze circulation moving through the air basin is called the local wind circulation (LWC). The LWC is caused by the uneven heating and cooling of the land and water surface. This diurnal wind tends to blow downslope towards the lake at night, when the lake is warmer than the land. During the daytime, when the land is warmer than the lake, the winds flow upslope into the valleys and mountains. This tends to cause a mixing of air in the center of the lake along a north/south axis during the day. The LWC is the predominant wind factor in the basin and winds rarely exceed 10 miles per hour, although passing storms cause higher wind velocities. The LWC produces a constant interchange of air in the basin, but only limited exchange with air external to the basin.

Rush Valley has between 10 and 12 inches of precipitation annually. The average annual temperature ranges from a high of 75° F to a low of 28° F, with a 10-year high of 104° F and a low of -14° F. Nocturnal temperature inversions, caused by extensive nighttime cooling, occur frequently in Rush Valley. The Valley floor is, on the average, 3° F cooler than the foothills due to this. The average spring and fall frost dates are 1 April and 25 October, respectively (U.S. Army 1982).

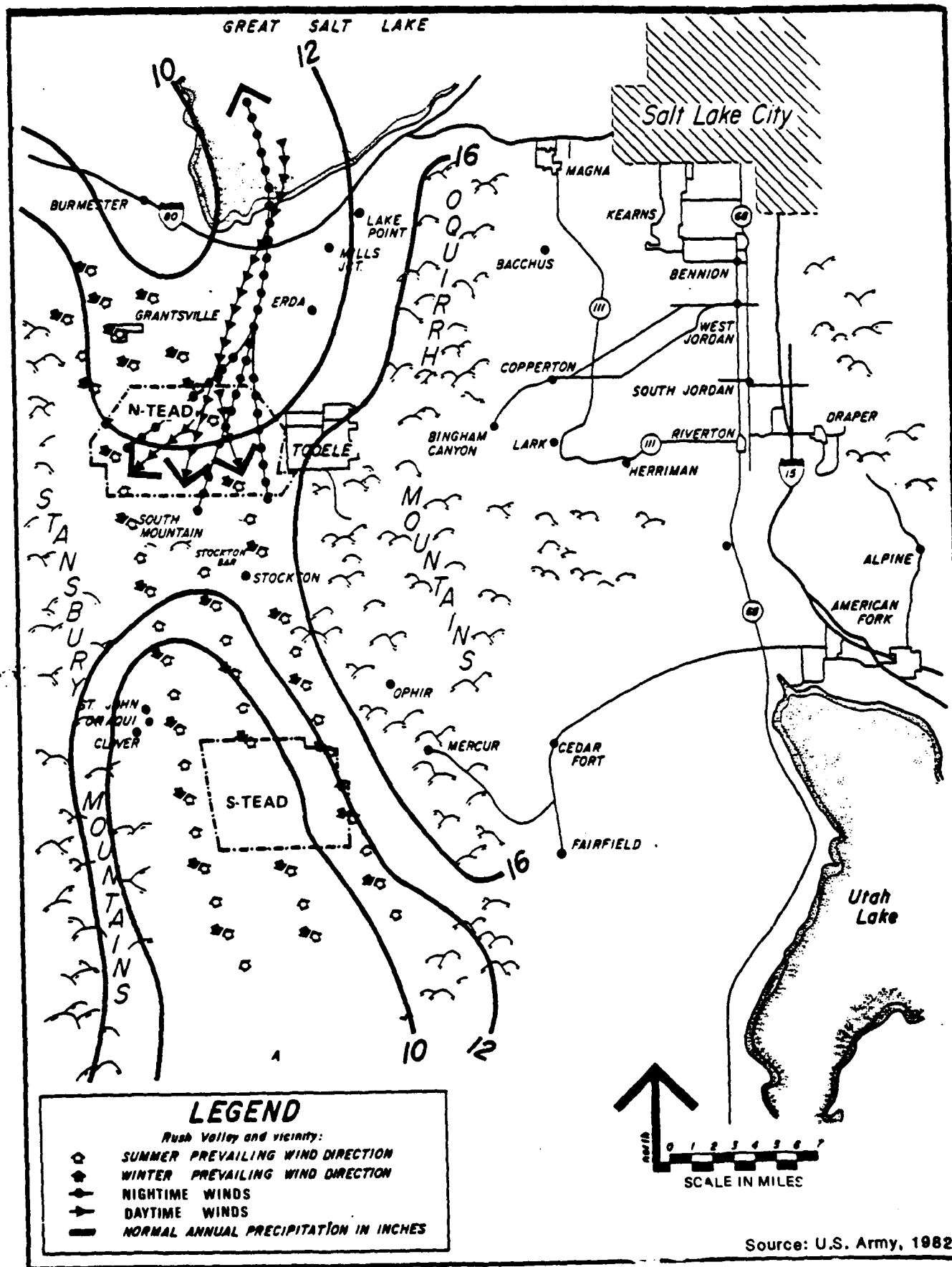


Figure 2-5. Precipitation and prevailing winds.

3. PHYSIOGRAPHY

3.1 REGIONAL GEOLOGY

S-TEAD is located in the Basin and Range Physiographic Province, approximately 35 miles west of the Wasatch Fold and Fault Belt of the Overthrust Physiographic Province. The Basin and Range Geologic Province is characterized by large enechelon fault blocks bounded by "down-on-the-west" normal faults that trend approximately north to south. Movement along the faults has been extensive since the late Miocene Epoch with hundreds to thousands of feet of displacement in places. This has allowed for large interior drainage basins to form between fault blocks, with extensive alluvial and lacustrine deposits forming within (Hood et al. 1969).

S-TEAD is located in a large interior drainage basin (Great Salt Lake Basin), bounded on the north and east by the Great Salt Lake and Oquirrh Mountain fault block, on the south by the Sheeprock and Tintic Mountain fault blocks, and on the west by the Stansbury Mountains fault block. Displacement along the control faults has been extensive, exposing rocks ranging in age from Pre-Cambrian and Cambrian (approximately 600 million years ago) to Tertiary and Quaternary. Interspersed within these rocks are igneous (volcanic) rocks of geologically recent age (Tertiary) intruded into the fault block mountains simultaneously with fault displacement (Moore and Sorensen 1979).

Alluvial and lacustrine sediments lie in the valleys between these fault block mountains and were deposited as pediment slopes from mountain drainage courses and as lake bed deposits in the large inter-mountain Lake Bonneville of the late Tertiary Period.

The valley fill consists of deposits of two ages, an older sequence of Tertiary age and a younger sequence of Quaternary age. The older sequence comprises the Salt Lake Group and consists of moderately consolidated sand, gravels, silts, and clays with an abundance of volcanic ash (Everitt and Kaliser 1980). The group is characterized by considerable deformation by tectonic processes. Razem and Steiger (1981) noted an increase in the fraction of finer-grained materials at a depth of 800-900 feet and suggest that this level may mark the top of sediments of Tertiary age.

The younger sequence of the valley fill unconformably overlies the Salt Lake Group and consists of relatively unconfined deposits of mostly unconsolidated sand, gravel, silt, and clay of Quaternary age (Everitt and Kaliser 1980). This sequence includes pre-Lake Bonneville alluvium of Pleistocene Age, Lake Bonneville deposits of Pleistocene Age, and deposits of recent age which include alluvium, lake beds, and dune sands (Gates 1965).

The sediments of the younger valley fill occur in irregular, interfingering layers. Alluvial and lacustrine depositional environments alternated several times during the Tertiary and Quaternary (Gates 1965), although alluvial processes probably dominated around basin margins, with lacustrine processes dominating toward the center. Beds of alluvial gravel thin and pinch out between beds of silt and clay towards the center of the basin (Everitt and Kaliser 1980). The surficial geology of S-TEAD is shown in Figure 3-1.

Regional Basin and Range tectonism has resulted in the formation of a variety of mineral deposits which are extensively mined in the general area of TEAD. A listing of the mineral resources developed in the Wasatch Front is provided in Table 3-1.

3.2 REGIONAL HYDROGEOLOGY

The groundwater flow systems at S-TEAD are part of a larger regional system that includes Rush Valley and Tooele Valley. Figure 3-1 illustrates this regional flow system and shows general directions of groundwater movement. Groundwater within the regional flow system moves from areas of recharge to areas of discharge. The recharge areas in this regional flow system lie along the valley edges. Recharge occurs principally from the loss of water from streams that originate in the mountain ranges surrounding the valleys. These streams typically disappear as they travel across the coalesced colluvial fans that slope from the mountain front towards the center of the valleys. Typical of such a stream is Ophir Creek which enters the South Area near its northeast corner. Recharge from mountain streams are also concentrated along narrow zones where basin boundary faults cut across the colluvial fans.

Discharge areas for the regional flow system are of two types. Discharge may occur to adjacent flow systems through connected alluvial valleys. An example of this is the discharge of about 5,000 acre feet per year (Razem and Steiger 1981) from the Rush Valley to the Tooele Valley under the Stockton Bar. The other major type of discharge area for the regional flow system occurs in the low portions of the valleys where water is discharged to evapotranspiration and surface waterbodies. Discharge to evapotranspiration occurs in the low part of Rush Valley along the southwest boundary of the South Area. Discharge to Rush Lake in the north end of Rush Valley may also occur seasonally. This lake may also serve both as a recharge and a discharge area. Recharge occurs when surface runoff collects in the lake. Discharge may occur when surface water is not present and any recharge mound from infiltration surface water has dissipated. The major discharge area for the regional groundwater system at S-TEAD is the Great Salt Lake.

The major perennial mountain streams which recharge the groundwater reservoir through the alluvial aprons and influence the chemical character of groundwater in Rush Valley are Soldier, Ophir, Clover, and Vernon Creeks (Hood et al. 1969). Background water quality data for

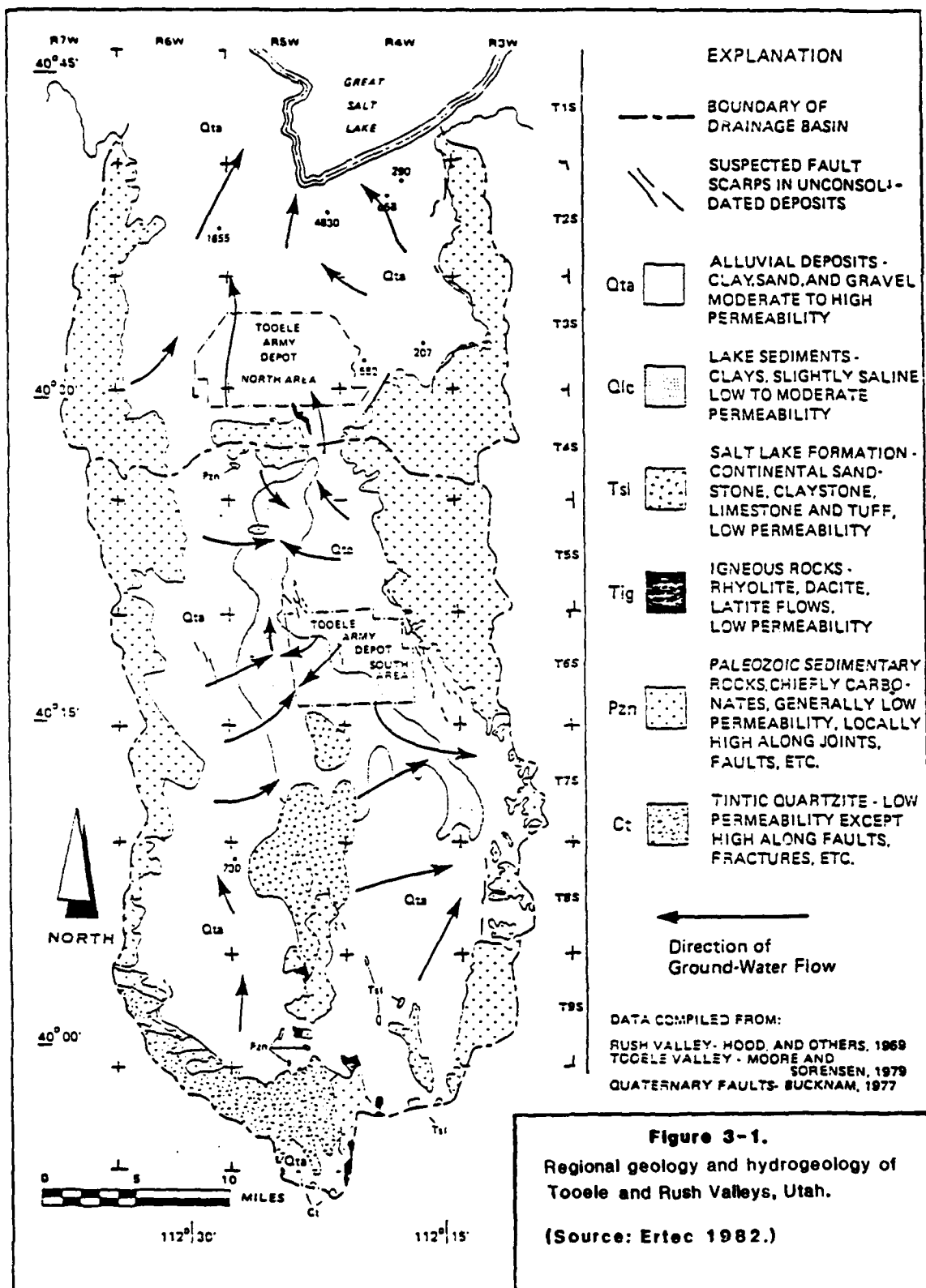


TABLE 3-1 MINERALS IN THE WASATCH FRONT

<u>Mining District and County</u>	<u>Minerals Extracted</u>
Alta, Salt Lake	Pb, Ag, Zn, Cu, Mo, Au, W, As, Bi, Sb, Mn, Ba, Fe
Big Cottonwood, Salt Lake	Pb, Ag, Zn, Cu, Au, Mo, Mg, Ba
Bingham, Salt Lake	Cu, Au, Pb, Ag, Zn, Mo, Hg, As, Bi, Sb, Se, Te, Ba
Blue Bell, Tooele	Pb, Ag, Au, Be, F, Ba
Columbia, Tooele	Pb, Ag, Cu, Zn, F
Dugway, Tooele	Pb, Ag, Zn, Cu, F, Ba
Gold Hill, Tooele	Au, Cu, Pb, Ag, Mo, W, As, Bi, Ba, Sb
Mercur, Tooele	Au, Ag, As, Sb, Te, Be
Ophir, Tooele	Cu, Au, Pb, Ag, Zn, Mn, W, Ba
Osceola, Tooele	Au, Ag, Hg, As, Sb, Te, Ba
Sierra Madre, Weber	Cu, Au, Pb, Ag, Zn, Mo, Fe
Silver Islet, Tooele	Cu, Pb, Ag, Ba
Stockton, Tooele	Cu, Au, Pb, Ag, Zn
Willow Springs, Tooele	Au, Cu, Pb, Ag, Mo, W, As, Bi, Ba, Sb

Source: Tooele Army Depot 1985b.

SYMBOLS USED:

Ag - Silver	Hg - Mercury
As - Arsenic	Mn - Manganese
Au - Gold	Mo - Molybdenum
Ba - Barium	Pb - Lead
Be - Beryllium	Sb - Antimony
Bi - Bismuth	Se - Selenium
Cu - Copper	Te - Tellurium
F - Fluorene	W - Tungsten
Fe - Iron	Zn - Zinc

specific chemical compounds within groundwater of Rush Valley are not readily available from the literature. However, the general quality of groundwater within Rush Valley has been classified. According to Hood et al. (1969), the principal constituents of the groundwater in Rush Valley are calcium, sodium, chloride, magnesium, sulfate, and bicarbonate. The general chemical composition of groundwater beneath alluvial slopes is similar to that of the perennial mountain streams where dissolved solids concentrations range from 200 to 338 ppm, with calcium and bicarbonate the principal constituents. Towards the valley center, dissolved solids concentrations range from 138 to 2,180 ppm, where the principal constituents are calcium, magnesium, sodium, chloride, bicarbonate, and sulfate (Hood et al. 1969).

The change from the calcium bicarbonate type to the sodium chloride type or a mixture of the two types occurs as a result of the dissolution of ions as the water moves from recharge areas through the valley fill, toward discharge areas (Figure 3-2). A change in water-level gradients due to pumping at wells may also induce the movement of water of the sodium chloride type into areas where the water is of the calcium bicarbonate type to form a mixture of the two types. In addition, the various minerals prevalent in this region (Table 3-1) are likely resulting in the geochemical alteration of the metals content of groundwater quality as it flows through Rush Valley.

The general movement of groundwater within S-TEAD is controlled by the regional recharge and discharge described above. Superimposed upon the regional features, however, are local sources and sinks of water that are important in the local movement of groundwater and contaminants. The following sections discuss the hydrogeology of S-TEAD in terms of the materials comprising the aquifers; the occurrence of groundwater under confined, unconfined, and perched conditions; and the local directions of movement from recharge to discharge areas, both natural and those caused by human activities at S-TEAD.

3.3 LOCAL HYDROGEOLOGY

The surficial geology of the S-TEAD is shown in Figures 3-3 and 3-4. Lacustrine, colluvial, and alluvial sediments comprise most of the surficial geology and extend to a depth of 500 feet (150 meters) or more. A log of the S-TEAD Supply Well No. 1 shows that 404 feet of typical valley-fill type sediments were penetrated. The basin fill is mostly of Tertiary Age with Quaternary deposits toward the center of the site forming thin gravel caps on pediments eroded on the Salt Lake Group. The bedrock underneath the valley fill is comprised of carbonate rock of Paleozoic age. These rocks are similar to those that crop out along the mountains on the east, south, and west.

The geology of Rush Valley exhibits typical Basin and Range structure, as it is composed of a number of small horsts and grabens. S-TEAD is situated on one of these structural features known as the Mid-Valley Horst. This feature was identified by the presence of the two nearly

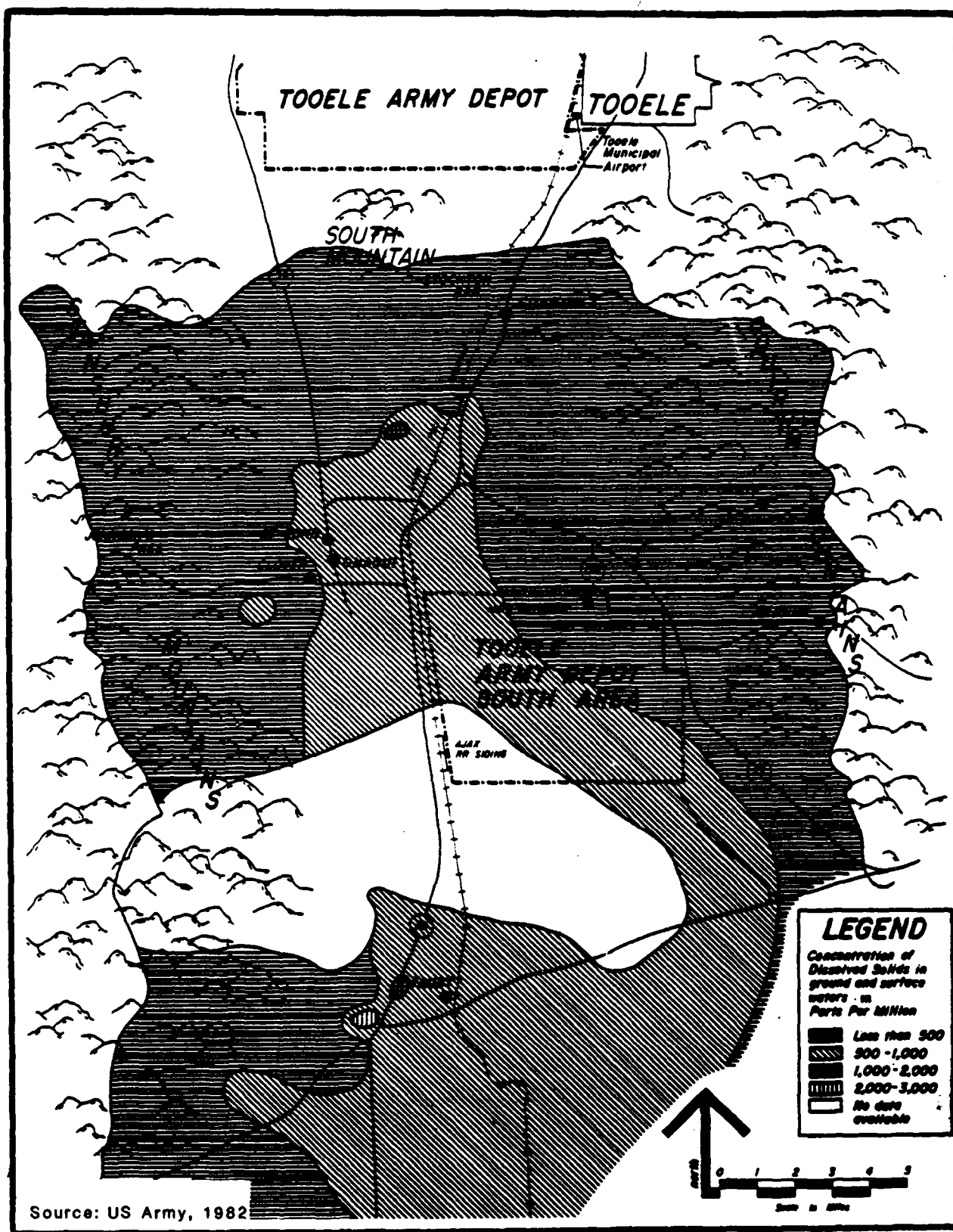


Figure 3-2. Generalized distribution of dissolved solids in the ground water of Rush Valley, Utah.

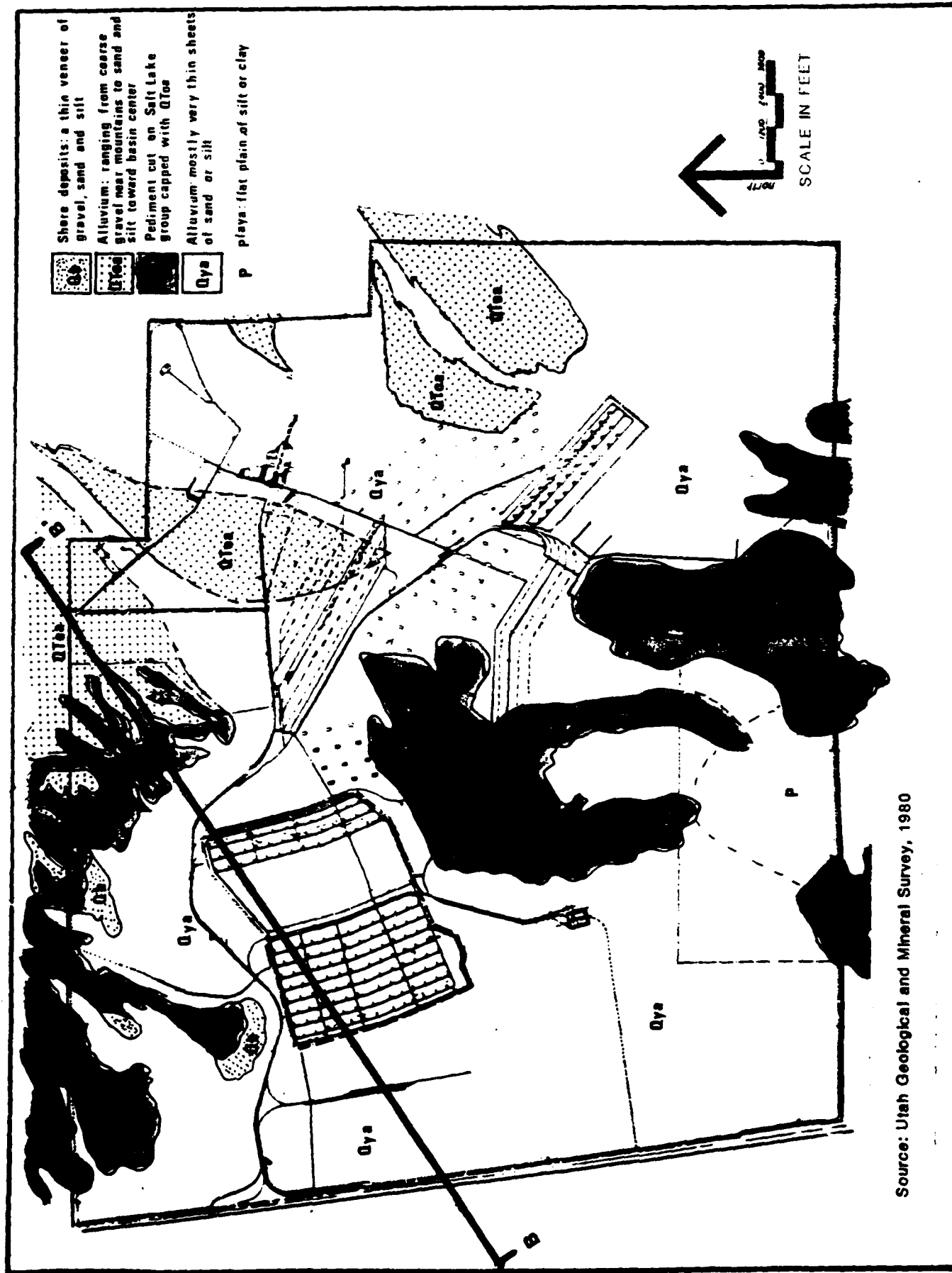


Figure 3-3. Surficial geology of S-TEAD.

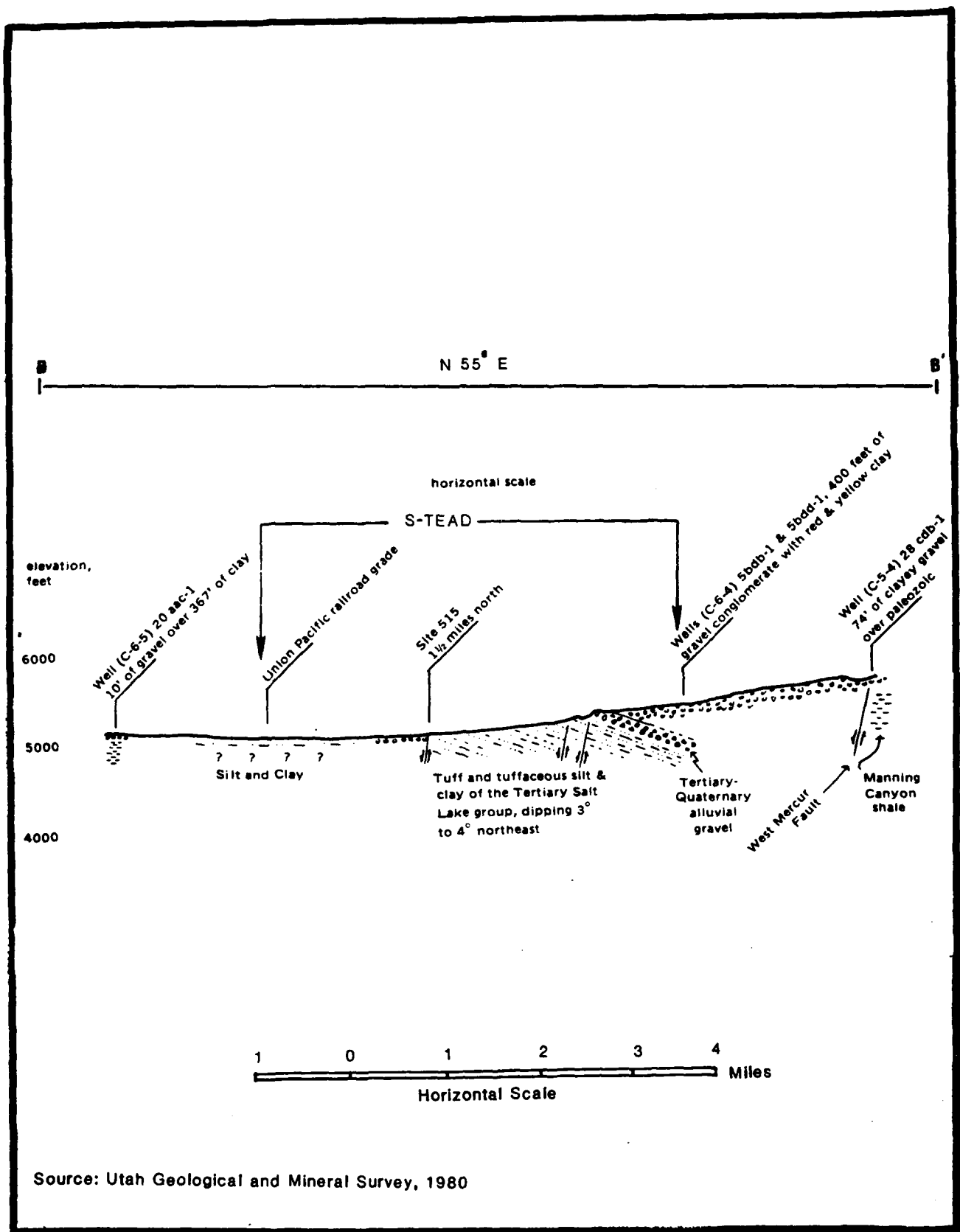


Figure 3-4. Generalized geologic cross-section for S-TEAD.

parallel series of fault scarps, trending northwest to southeast, just off the northern portion of the southern S-TEAD area (Everitt and Kaliser 1980). The western scarps are down-thrown to the west, and the eastern scarps are down-thrown to the east.

A fault associated with the Mid-Valley Horst fault system runs north-south near the center of S-TEAD across the Ammunitions Storage and Igloos Area 9. The fault scarps are in the recent sediments and do not expose bedrock at the surface (Figure 3-4).

The influence of this structural feature is unknown. It is assumed that the bedrock associated with the Mid-Valley Horst is deep enough that its effects on the area's groundwater flow are minimal (Ertec 1982).

Groundwater in the S-TEAD occurs generally under unconfined conditions with local areas of confined conditions. Figure 3-5 shows the potentiometric contours and direction of groundwater flow within the unconfined regional water table aquifer at S-TEAD based on static water level measurement data obtained during this study (Table 3-2). The depth to water in the South Area ranges from 300 feet in the northeast corner to less than 15 feet in the southwest corner.

Recharge to the South Area groundwater system occurs from both the northeast and the west. Ophir Creek is a perennial stream originating in the Oquirrh Mountains and enters the Depot property as an intermittent stream in the northeast corner and disappears into the alluvium near Ammunition Storage and Igloos Area 9. Water derived from rainfall and snowmelt from the Oquirrh Mountains is the principal source of recharge to the alluvial fans bounding the eastern side of the Depot. Groundwater also enters the southwestern and western portion of the Depot property as recharge from the Onaqui Mountains.

The southern and southwestern part of S-TEAD is a discharge area for the groundwater system. Groundwater from both the northeast and the west flows into this area and is discharged by evapotranspiration. This area has the lowest topographic elevation on the Depot. Flooding of this area occurs during spring snowmelt causing saturated conditions to extend nearly to the land surface. The depth to water in this area is very shallow, ranging from 8 feet at Well S-1 to 58 feet at Well S-4 (Figure 3-5). Groundwater from wells drilled in the southern and southwestern areas of the Depot has very high electrical conductivity, ranging from 10,000 umhos/cm at 25° C (Well S-4) to 54,000 umhos/cm at 25° C (Well S-14). The high electrical conductivities are probably the result of dissolution of soluble inorganic constituents from the underlying valley fill deposits, concentration of these constituents by evapotranspiration, and stagnation caused by slow moving groundwater in areas of low permeability.

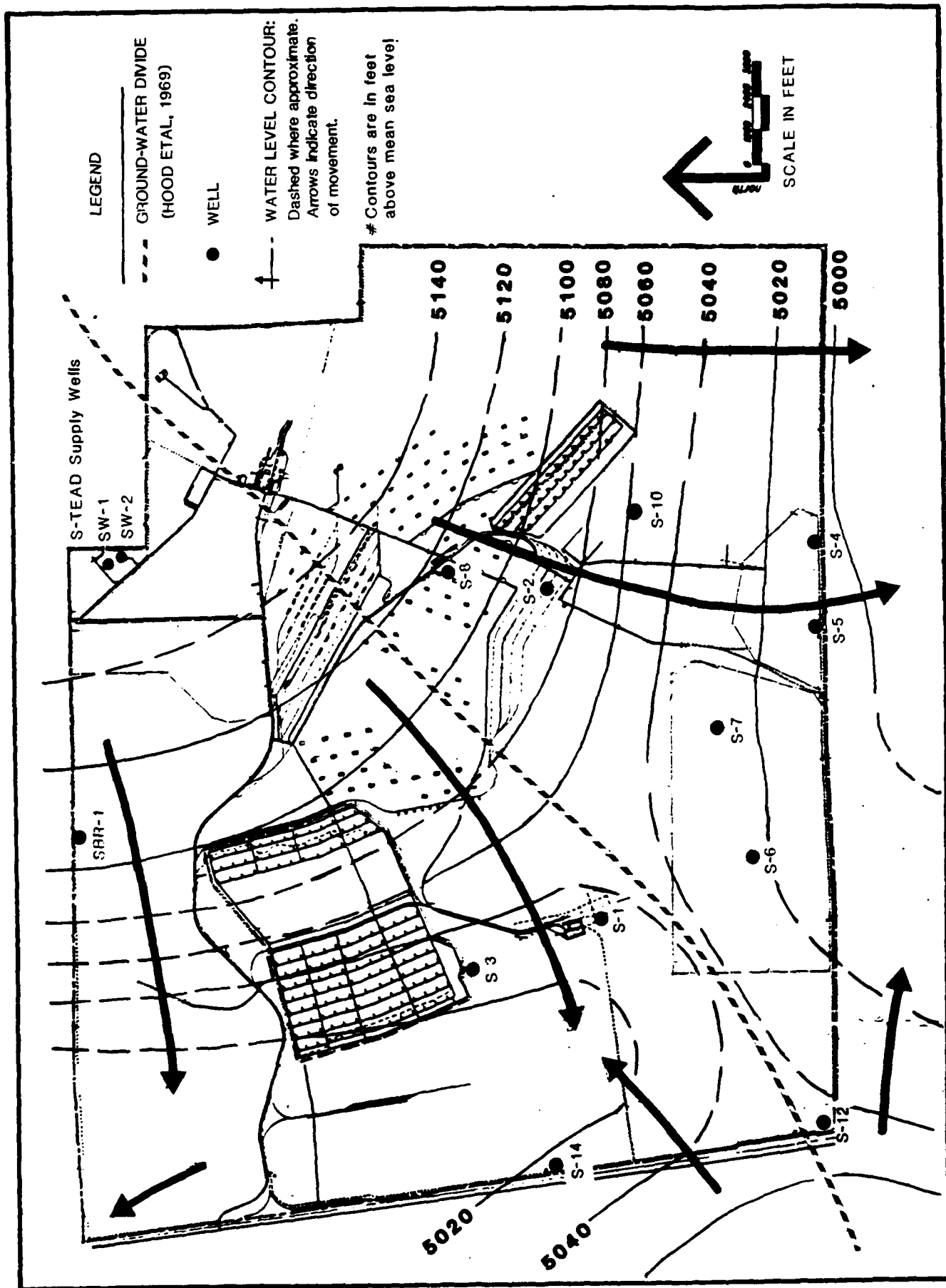


Figure 3-5. S-TEAD potentiometric surface map.

TABLE 3-2 SUMMARY OF WATER LEVEL DATA OBTAINED DURING PA/SI PROGRAM, S-TEAD

Well Number	Measured Depth to Water (ft BTC ^a)		Well Casing Elevation (ft MSL ^b)	Water Level Elevation (ft MSL ^b)	
	4/20/86	2/18/87		4/20/86	2/18/87
CAM-1	---	11.40	5,041.44	---	5,030.04
CAM-2	---	11.60	5,042.04	---	5,030.44
CAM-3	---	11.40	5,042.53	---	5,031.13
SBR-1	---	121.97	5,229.38	---	5,107.41
S-1	6.47	7.67	5,040.98	5,034.51	5,033.33
S-2	59.58	59.48	5,148.50	5,088.92	5,089.02
S-3	23.92	25.21	5,053.91	5,029.99	5,028.70
S-4	60.85	60.65	5,067.49	5,006.64	5,006.84
S-5	37.20	26.91	5,051.29	5,014.09	5,024.38
S-6	---	17.65	5,039.20	---	5,021.55
S-7	---	25.32	5,048.57	---	5,023.25
S-8	77.45	73.64	5,190.16	5,112.71	5,116.52
S-10	69.41	69.28	5,125.51	5,056.10	5,056.23
S-12	6.65	7.30	5,054.46	5,047.81	5,043.99
S-14	11.46	11.07	5,039.08	5,027.62	5,028.01

(a) BTC = Below top of casing.

(b) MSL = Mean sea level.

NOTE: Dashes (---) indicate not taken.

The South Area's water supply is obtained from Well Nos. 1 and 2, located in the northeastern corner of the Depot (Figure 3-5). Well 1 provides most of the water supply used. The areal extent of the cone of depression around Well 1 is unknown because of a lack of any additional well data from this area. Ophir Creek runs between Supply Well No. 1 and Well No. 2, and probably provides recharge by leakage to the aquifer; this probably reduces the areal extent of the cone of depression caused by pumping either of these wells. The depth to water in Well 2 is 285 feet. According to lithologic logs (Hood et al. 1969), groundwater is probably under unconfined water table conditions in this area.

Shallow groundwater occurs under unconfined water table conditions throughout the remainder of the South Area. Depth to water is fairly shallow (no greater than 68 feet in any of the wells drilled by Ertec). One exception is at the site of Boring S-9, which is in the Demilitarization Area/Disposal Pits, north of Well Nos. S-4 and S-5. The boring was terminated at a depth of 110 feet after penetrating a sticky clay layer of unknown thickness. There was no evidence of the water table at this depth. Groundwater may also occur under confined conditions at this location.

3.4 LOCAL SOILS

Most of Rush Valley is slightly saline, with strongly saline soils in the center. However, they are considered arable or potentially arable with drainage. Soils on the S-TEAD are predominantly Neola gravelly loam (U.S. Army 1982). These are shallow soils, with a lime-cemented, gravelly hardpan within 20 inches of the surface and gravelly loam underneath. They are moderately saline and alkaline, especially in the subsoil. Soils on the southern and western boundaries are deep, silty, clay loams; silt loams of alluvial flood plains and valley floors are saline and alkaline, and have low permeability. The higher alluvial fans, on the northern and eastern boundaries, have very deep, well drained, silt loams, gravelly loams, and gravelly-clay loams. Although the soils generally are arable or potentially arable, due to low natural rainfall, they are rarely farmed in the region except under irrigation. The predominant use off the facility is as rangeland. A small area of deep silt loam soils near Ophir Creek was under cultivation prior to construction of the S-TEAD. Much of the soil at S-TEAD has been disturbed by construction and operation of the facility.

3.5 LOCAL TOPOGRAPHY AND SURFACE DRAINAGE

The topography of S-TEAD is illustrated in Figure 3-6. The South Area of the TEAD is located in Rush Valley. Rush Valley is considered to be a topographically closed valley. The north trending valley is bordered by the Oquirrh and East Tintic Mountains on the east, the Stansbury and Onaqui Mountains on the west, and the Sheeprock and West Tintic Mountains on the south. Rush Valley is topographically separated from Tooele Valley to the north by the Stockton Bar, which is a bay-mouth bar built

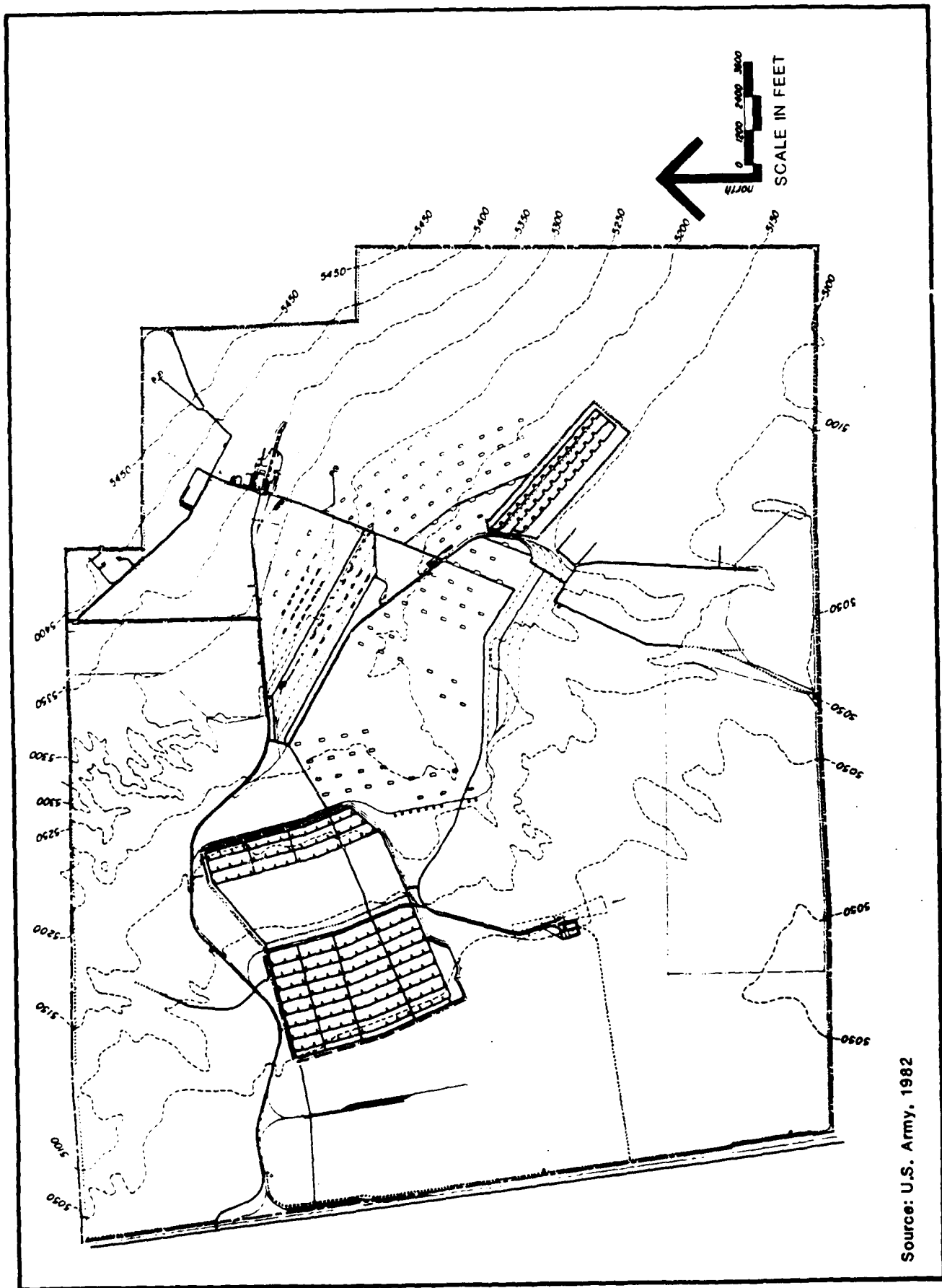


Figure 3-6. Topographic map of S-TEAD.

between South Mountain and Oquirrh Mountains by Pleistocene Lake Bonneville (Everitt and Kaliser 1980). The mountain crests range in elevation from approximately 9,000 feet (Sheeprock Mountains) to 10,500 feet (Oquirrh Mountains). The slope of the Valley floor is northward to Rush Lake, which has an altitude of approximately 5,000 feet. The Rush Valley floor is approximately 30 miles long and 17 miles across at its maximum width.

There is no permanent surface water flow in S-TEAD. An intermittent stream, Ophir Creek, crosses the northeast boundary and flows in a southwesternly direction. This stream, generally dry except during moderate rainfall events, flows across the site until it infiltrates completely into the alluvium in the vicinity of the Ammunitions Storage and Igloos Area 9. Water from Ophir Creek is diverted for agricultural use prior to entering the site at the northeast corner and generally has little or no flow into the site (U.S. Army 1982). Intermittent drainages that occasionally carry some water onto the facility include Mercur Creek, West Dip Gulch, and other unnamed drainages, all from the Oquirrh Mountains. The playa and other low areas on the valley bottom in the western and southwestern portion of the site flood during periods of heavy runoff (Hood et al. 1969).

No surface water leaves Rush Valley. Surface water is lost by infiltration on the alluvial slopes of the valley and by evapotranspiration in vegetated areas. A small amount of surface water reaches either playas in the east central part of the valley or Rush Lake at the northern boundary of the valley, where it is evaporated.

4. HAZARDOUS SUBSTANCES CHARACTERIZATION

4.1 WASTE SOURCES

S-TEAD has served primarily as a facility for the storage and maintenance of both bulk chemical agents and chemical weapons. The operations at S-TEAD which resulted in the generation of materials/wastes with toxic or hazardous properties stemmed predominantly from the renovation and demilitarization of conventional and chemical munitions and chemical agent materials. A summary of the various activities involving the use/generation of hazardous substances at S-TEAD is provided in Table 4-1.

4.2 WASTE DISPOSAL/TREATMENT METHODS

The waste disposal/treatment methods used at S-TEAD include the following:

- . Detonation of conventional munitions in the Old Demilitarization Range
- . Burning and release of chemical agents and munitions in the Demilitarization Range and the Windrow Area
- . Burial of explosive and chemical munitions at the Gravel Pit and the Demilitarization Range
- . Evaporation/percolation ponds for the handling of bomb washout residue, laundry effluent, and domestic sewage effluent
- . Landfilling of sanitary wastes
- . Biological treatment (Imhoff tank) of domestic sewage
- . Neutralization and thermal destruction of chemical agents and munitions at CAMDS.

TABLE 4-1 HISTORICAL SUMMARY OF ACTIVITIES INVOLVING THE USE OF HAZARDOUS MATERIALS AT S-TEAD

<u>Building No.</u>	<u>Activity</u>	<u>Potential Contaminant</u>
S-108	Processing M12 (machine gun) links, welding	Hydrochloric, chromic, and phosphoric acids; metal dust
S-541	CW agent surveillance, drinkingwater analysis	Small quantities of CW agents, perchloric acid
554	Demilitarization of M14 incendiary cluster bombs	Tetryl, thermate mix, cadmium dust, first fire mix
T-600	Renovation of M4-A2 smoke pots, M15 WP grenades, and H-filled rounds	Smoke producing mixture, paint pigments; WP, possibly chromic acid; (H) mustard
CAMDS	Demilitarization procedure testing for toxic chemical munitions	Chemical agents GB and VX

Source: USATHAMA 1979.

5. SUMMARY AND FINDINGS OF PREVIOUS ENVIRONMENTAL INVESTIGATIONS

This chapter summarizes environmental investigations conducted at S-TEAD prior to the current effort. A discussion of the scope of work, findings, and conclusions is presented. Only reports of in-depth (Depot-wide) investigations are summarized in this chapter. Other site-specific investigations involving limited sampling and analysis are presented in Chapter 6 (Preliminary Site Assessments).

5.1 INSTALLATION ASSESSMENT OF THE TOOEE ARMY DEPOT, REPORT NO. 141

This investigation was initiated in response to a request by the Chemical Demilitarization and Installation Restoration Agency (now USATHAMA) to identify and conduct a Phase I investigation at all potentially contaminated Army installations (USATHAMA 1979). The report provides an assessment of the environmental quality of N-TEAD and S-TEAD with respect to the use, storage, treatment, and disposal of toxic and hazardous materials, and to identify any sites which may pose a threat to public health and welfare or the environment. The study included the retrieval and review of available records and interviews with present and former TEAD employees.

The onsite phase of the study was conducted from 6 to 15 December 1978.

The findings of the investigation for S-TEAD are summarized below:

- . Groundwater flow in northwest S-TEAD is to the west and then drains to the north toward Rush Lake. Through the south and east sections of S-TEAD, groundwater flow is to the south and east, through the Five and Ten Mile Passes.
- . There are several active sanitary landfills located in S-TEAD, however, no hazardous materials are reported to have been placed in any of the facilities.
- . Several areas of S-TEAD have been used for burial of contaminated wastes, including a pit located south of Storage Area 2 containing "a little bit of everything" as reported by TEAD employees.
- . The Demolition Area disposal pits located in the southeast area of S-TEAD were used for the disposal of chemical agents, munitions, and explosives. The majority of the pits are marked and the contents identified. However, four pits designated as 27 through 30 have not been located nor has past usage been determined.

- . Sites for demilitarization in S-TEAD are:
 - Building 554--Thermate washout (Inactive)
 - Demolition Area/Disposal Pits (Inactive)
 - Building 520--Deactivation furnace (Inactive)
 - CAMDS System (Active)
- . There were H spills in the Mustard Holding Area in the Demolition Area, and Former Holding Area of Storage Area 2.
- . There was a VX leak reported in the southeast corner of Storage Area 2.
- . There was an oil spill in the CAMDS area.
- . An unlined drainage pond located east of Building No. 600 received HE cluster bomb washout water, and wastes from mustard munitions, white phosphorus, and HC smoke pot renovation.

The following conclusions were presented in the Installation Assessment Report:

- . A potential exists for contaminant migration via groundwater flow from the South Area.
- . The potential for contaminant migration via groundwater is created by the shallow groundwater flow beneath the old Demilitarization Area/Disposal Pits along the southern boundary.
- . The buried chemical munitions and contaminated soil in S-TEAD are a potential long-term hazard. The lack of information on the location and contents of the former Pits 27 through 30 would compromise remedial measures planned for the elimination of the hazard.
- . The leachate potential from the landfills and the composition of surface runoff cannot be characterized. This is due to lack of information, absence of NPDES permit requirements, and minimal requirements for landfill management.

5.2 ERTEC EXPLORATORY ENVIRONMENTAL CONTAMINATION ASSESSMENT REPORT

Under the direction of USATHAMA, the Earth Technology Corporation (Ertec) conducted a two-phase exploratory environmental survey of TEAD from October 1981 through October 1982 (Ertec 1982). The objective of the survey was to define the nature and extent of environmental contamination, and to determine the potential for offsite contaminant

migration. The investigation was conducted in a two-phased manner; the first phase consisted of a review of existing data and preliminary visits to identify sites posing the greatest potential for contaminant migration. This phase was accomplished during the period October-December 1981. The second phase involved the sampling and analysis of soil, sediment, and water for contaminants at sites identified during the first phase. The second phase was accomplished during January-July 1982. Fourteen wells or borings were drilled in S-TEAD. Soil, sediment, surface water, and groundwater samples were collected and analyzed during this period. The evaluation of data obtained from drilling, sampling, and chemical analyses resulted in (1) definition of the occurrence of groundwater including perched zones, mounds, discharge and recharge areas, regional, and local hydrogeology; (2) definition of contaminants at each sampling site; and (3) determination of problem areas where contaminants have the potential to migrate or are migrating off the Depot.

The following conclusions were presented in the Ertec report for S-TEAD:

- . The South Area is generally clear of contamination except for arsenic and gross-alpha and gross-beta.
- . Arsenic contamination above U.S. Environmental Protection Agency (EPA) and Utah water quality standards is present at the southern boundary of the South Area and is moving off-post because groundwater movement is to the south and southwest. The source of this contamination cannot be defined with available data, but may be naturally occurring or related to possible spills of arsenic-containing agents.

5.3 EVALUATION OF S-TEAD SOLID WASTE MANAGEMENT UNITS (SWMU), AEHA GROUNDWATER CONSULTATION REPORT NO. 38-26-1364-86

The purpose of the U.S. Army Environmental Hygiene Agency (AEHA) consultation, which was conducted from 28 July to 1 August 1986, was to review the adequacy of data submitted on all SWMUs in S-TEAD as part of the pending Resource Conservation and Recovery Act (RCRA) Part B Permit Application for the CAMDS facility (AEHA 1986). This review was conducted to identify any gaps in the existing SWMU database for the Part B Permit Application.

The Depot submitted, to U.S. EPA Region VIII and the the State of Utah, a list of 27 SWMUs in August 1985. Additional SWMU sites were added to the list based on information presented in the EPIC Report (U.S. EPA 1985) and during a site inspection conducted by U.S. EPA Region VIII, Utah Department of Health, TEAD, and AEHA. Table 5-1 lists all of the SWMU sites.

TABLE 5-1 SOLID WASTE MANAGEMENT UNITS (SWMUs), TOOELE ARMY DEPOT, SOUTH AREA

Location Number	SWMU	Site Type	Location Number	SWMU	Site Type
1	Demilitarization Area/ Disposal Pits	Disposal Pits, Covered Disposal Pits	17	Deactivation Furnace	Deactivation Furnace
2	Gravel Pit	Covered Disposal Pit	18*	Waste Storage Area S-753	Located in Tooele AD, North Area
3	Pit (Mustard Leaks)	Covered Disposal Pit	19*	Building S-533	Empty Drum Storage
4	Mortar Pits	Covered Disposal Pit	20*	Building S-521	Packaging Building for Smoke Pot and Tear Gas Grenades
5	Drainage Pond	Lagoon	21	Building S-554	Incendiary Washout Operations
6	Building 600	Munitions Washout/ Renovation Facility	22	Incendiary Washout Ponds	Lagoons
7	Leaching Pit	Lagoon	23	Demilitarization Holding Area	Open Storage Area
8	Surveillance Test Site	Munitions Testing Area	24	Old Demilitarization Shed, S-3200	Showers
9	Mustard Holding Area	Spill Site			
10	Area 9 Spill	Spill Site	25	Demilitarization Area/ Disposal Pits (Windows)	Waste Piles and Pits
11	Area 10	Chemical Munition Storage Area	26	Sanitary Landfill	Landfill
12*	Building S-118	Training Site	27	Sewage Treatment Plant	Wastewater Treatment Plant
13	Chemical Agent Munition Disposal Systems (CAMDS) Site	Totally Enclosed Demilitar- ization Facility	28**	Sanitary Landfill	Landfill
14*	Building S-108	Former Motor Pool	29**	Landfill	Landfill
15	Old Demolition Pit (under warehouse C4002)	Demilitarization Pit	30**	Landfill	Landfill
16*	Building S-119	Electrical and Carpentry Shops	31**	Demilitarization Area	Open Detonation Area

* SWMU to be removed from list; sites do not fit SWMU definition.

** SWMU added to list originally.

NOTE: Septic tanks with drainfields are utilized for sewage disposal in areas not served by the sewage collection system. The drainfields are widely scattered and the flows are relatively small.

Source: ASEA 1986.

The AEHA report identified sites which did not fit the SWMU description, SWMU sites which required no further environmental investigations, and SWMU sites where additional environmental work was recommended. All SWMU sites are described in detail in the AEHA report. The findings of the report were as follows:

. The following sites are not SWMUs:

- Building S-118
- Building S-108
- Building S-119
- Waste Storage Area S-753
- Building S-533
- Building S-521

. No further environmental investigation is needed for the following SWMUs due to low potential for release of hazardous wastes to the environment:

- Gravel Pit
- Pit (Mustard leaks)
- Mortal Pit
- Building 600
- Surveillance Test Site
- Area 9 Spill
- Area 10
- CAMDS Facility
- Old Demolition Pit
- Building S-554
- Incendiary Washout Ponds
- Old Demilitarization Shed, Building S-3200
- Demilitarization Holding Area
- Sanitary Landfills (total of 4)
- Sewage Treatment Plant
- Demilitarization Area

. Additional environmental investigation is needed for the following SWMUs which have moderate to high potential for release of hazardous wastes to the environment:

- Demilitarization Area/Disposal Pits
- Drainage Pond
- Leaching Pit
- Mustard Holding Area
- Deactivation Furnace
- Demilitarization Area/Disposal Pits (windrows)

5.4 ENVIRONMENTAL PHOTOGRAPHIC INTERPRETATION CENTER (EPIC) REPORT

The Environmental Photographic Interpretation Center, through an inter-agency agreement between U.S. EPA and U.S. Army, was requested to provide imagery analysis support for the USATHAMA Installation Assessment Project (U.S. EPA 1985). Archival black and white aerial photography, of an appropriate scale, was acquired from the imagery libraries of the U.S. Geological Survey (USGS) and the Agricultural Stabilization and Conservation Service. An attempt was made to locate imagery that would provide photo coverage for each installation at 5-year intervals spanning the 40-year period between 1940 and 1980. However, in some of the less-populated sections of the country, where only sparse photo coverage exists, this was not possible.

Due to the remote location of the Tooele Army Depot-South Area, little historical imagery of an appropriate scale was available. Black and white aerial photographs acquired in 1974, along with current low altitude color infrared photography, were analyzed to determine the potential environmental impacts of past and present installation activities. A 2-part mosaic of the installation was constructed using the 1974 photography. The original film, acquired from USGS, was flown at different scales: the western portion at 1:25,600 and the eastern portion at 1:36,000. The 2-part mosaic reflects this scale variance.

An overlay to the mosaic shows the location of potentially hazardous sites and activities, along with surface drainage, ground scars, extraction pits, and munition storage areas. The second overlay shows key areas that have been enlarged from the 1974 and 1981 photography to detail major sites on the installation. These enlargements are also discussed. In addition, a brief description of all potential sites, including changes that took place between 1974 and 1981, is presented.

6. PRELIMINARY SITE ASSESSMENTS

Based on information obtained from reviewing the available database and from employee interviews and site visits conducted during the onsite investigation, sites considered to present a potential source for environmental contamination were identified. A brief summary of the location, history, operations/activities practiced, and potential contaminants of concern at each site is presented.

6.1 CAMDS DIESEL SPILL

The CAMDS Facility is located in the southwestern area of S-TEAD (Figure 6-1). Located within the boundaries of the CAMDS Facility are three above-ground diesel tanks, each with a capacity of 30,000 gallons (Figure 6-2). Sometime between 1980 and 1985, an underground product-line leak of diesel fuel occurred. Apparently, the line leak went undetected for some time and an estimated 38,000 gallons of fuel was lost. The line leak was repaired, however, no action was taken to evaluate potential groundwater contamination at the site.

TEAD personnel also indicated that several other spills of diesel fuel have occurred at this site. A documented fuel spill occurred at CAMDS in January 1978 (USATHAMA 1979). Approximately 500 gallons of fuel oil was released onto the ground and was reportedly cleaned up in accordance with TEAD's Spill Prevention Control and Counter-Measure and Installation Spill Contingency Plan. (Sand was applied to the site to absorb the oil which was taken to the S-TEAD Demolition Grounds and burned.)

A high potential for groundwater contamination exists at this site due to the shallow depth to groundwater (approximately 6 feet below land surface). Well installation and sampling/analysis was conducted at the site during the PA/SI field effort. The field program results are discussed in Section 8.1.

6.2 CAMDS BOILER BLOWDOWN DISCHARGE SITE

Outside of the southern perimeter fence of the CAMDS Facility is an area where boiler blowdown water and water used for cooling of life support compressors is discharged to the ground surface (Figure 6-2). Life support compressors are operated 24 hours/day; therefore, discharge of water occurs on a continuous basis. Ponding of water in the discharge area occurs, indicating that a water mound may exist at this site.

According to CAMDS and the program manager for Chemical Munition Demilitarization personnel, sampling and analysis of the discharge has been conducted and results did not show any hazardous constituents at concentrations above allowable levels. However, these results were not made available to EA. A monitoring well (S-1) is located approximately 1,000 feet to the south and downgradient of the discharge area. This well was tested by Ertec (1982) and the results did not indicate any

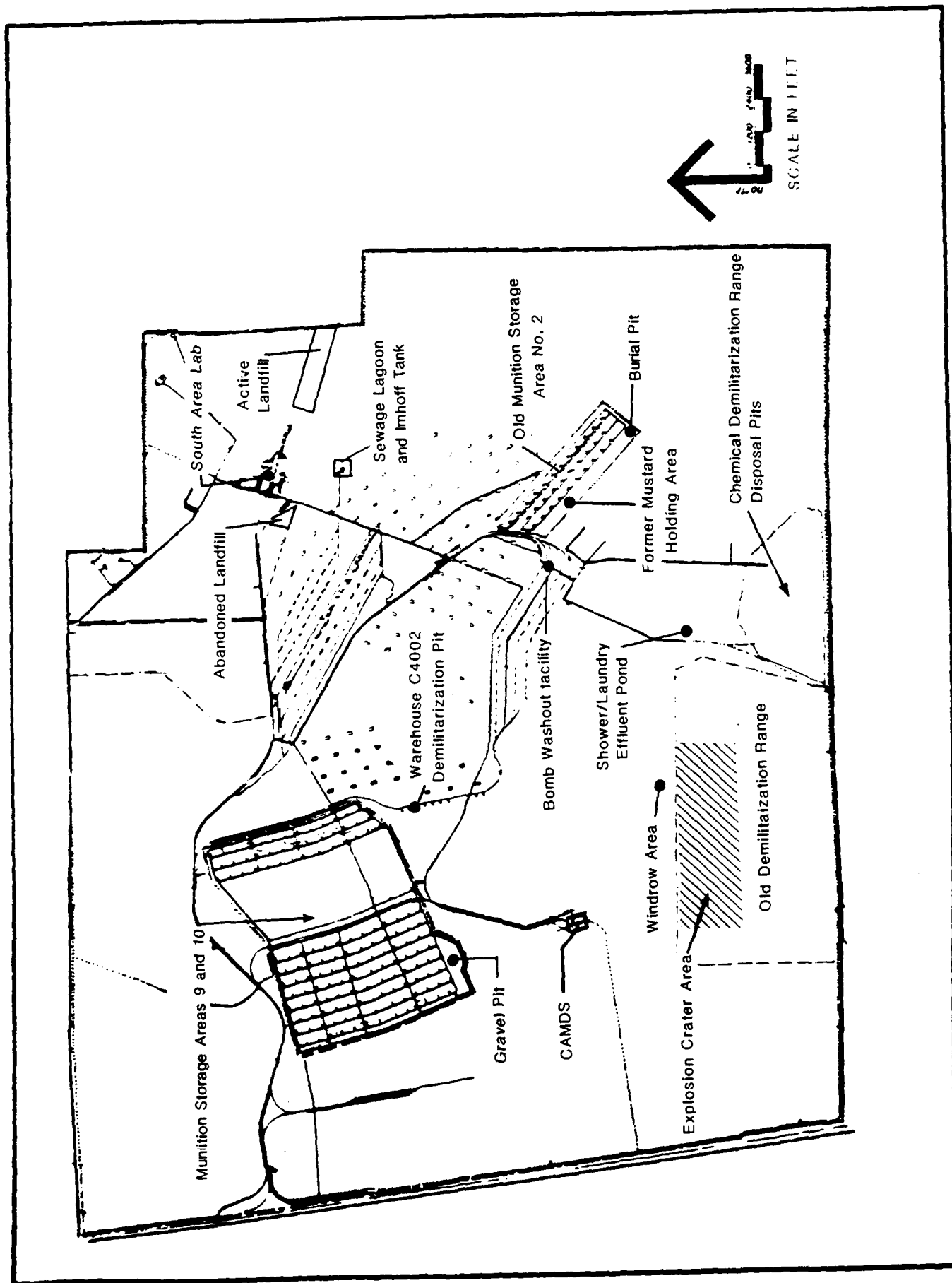


Figure 6-1. Locations of potential hazardous waste sites at S-TEAD.

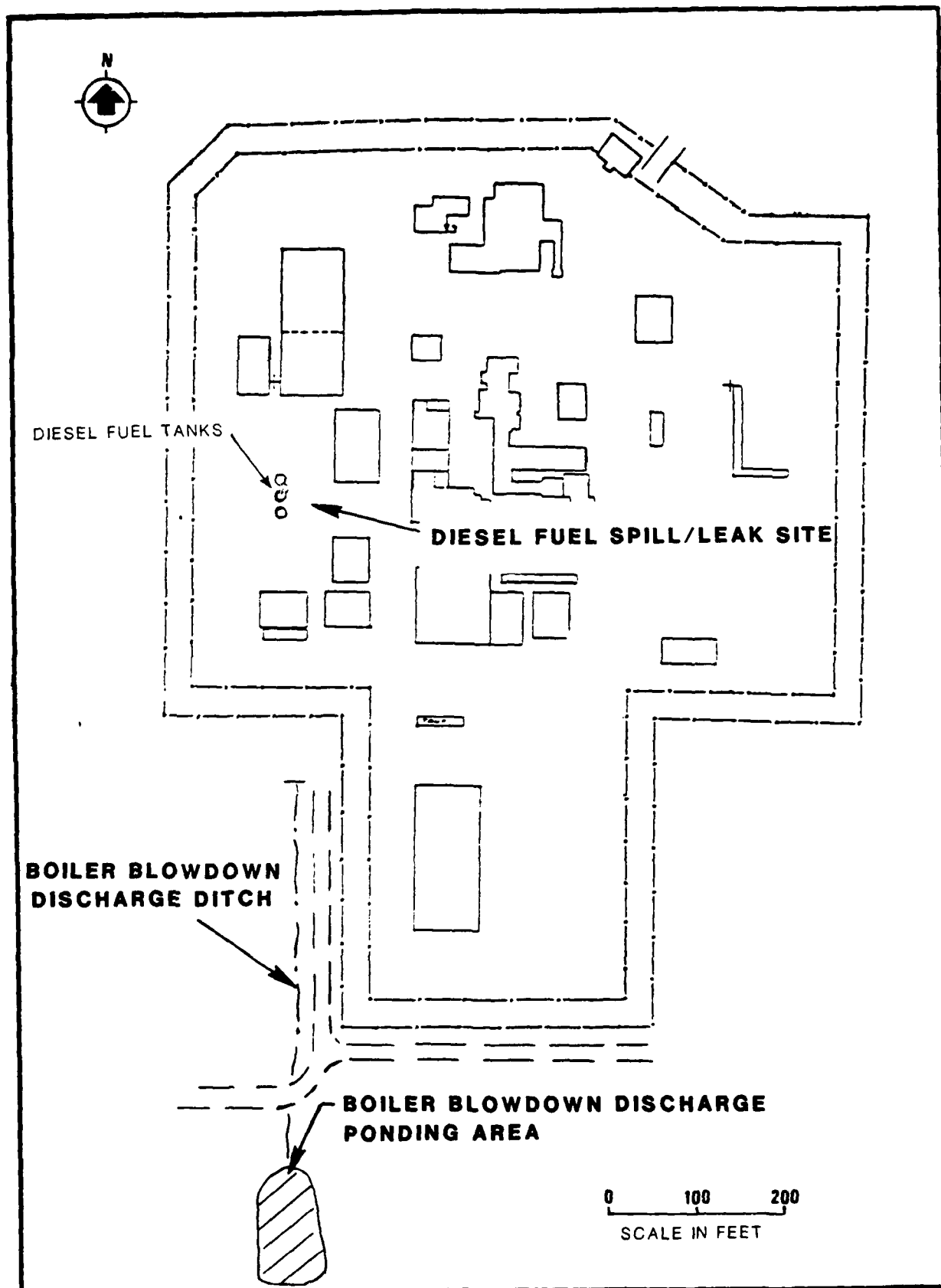


Figure 6-2. Map of CAMDS Facility, S-TEAD.

groundwater contamination problems. Sampling and analysis of the discharge was conducted during the PA/SI Program. The results of this analysis are discussed in Section 8.1.

6.3 BOMB WASHOUT FACILITY

In the central-eastern portion of S-TEAD (Figure 6-1), an unlined evaporation/percolation pond is located approximately 125 feet east of former Building No. 600 which received rinsewater from washout operations housed in Building No. 600 (Figure 6-3). Building No. 600 was used to renovate HE (high explosives) cluster bombs from 1940 to 1958. Reportedly, Mustard projectiles, WP, and HC smoke pots were also renovated in this building (USATHAMA 1979). Building No. 600 has been demolished and only the concrete foundation pad and concrete settling basin remain. The unlined Bomb Washout Pond presently consists of a 10-foot deep basin, approximately 32 feet by 95 feet. The Pond is surrounded by a barbed wire fence. There is no record of any sampling having been conducted at this site. Based on the lack of analytical data and the potential for contamination, this site was included in the PA/SI field program (Section 8.2).

6.4 SHOWER/LAUNDRY EFFLUENT HOLDING PONDS

Located in the south-central portion of S-TEAD (approximately 1 mile east of the explosion craters) and just east of Building No. S-3200 were two unlined ponds that received wastewater from Building No. S-3200 (Figure 6-1). From an inspection of the EPIC photos, the ponds were receiving wastewater in 1959. It is not known if the ponds were connected by overflow pipes. In the 1966 EPIC photo, the northernmost pond was closed and the southernmost pond was still present. There is no information on activities at the facility. Based on a site inspection, Building No. S-3200 appears to have been used as a laundry and/or showering facility. The existing drainage pond is a 7-foot deep pit, 53 feet by 27 feet in dimension, located approximately 50 feet east of abandoned Building No. S-3200. There is no record of any sampling having been conducted at this site. A soil sample was obtained from the existing pit and analyzed during the PA/SI field effort. The results of the analysis are discussed in Section 8.3.

6.5 EXPLOSION CRATERS

Located on the south-central boundary of S-TEAD is the Old Demilitarization Range, covering approximately 1,500 acres (Figure 6-1). Documented information on the history or operation of the area is not available. It was indicated by TEAD personnel that only conventional munitions were demilitarized in this area. In the western portion of the Old Demilitarization Range are groupings of large Explosion Craters. These craters are present in the 1974 and 1981 EPIC photos and were observed during the site visit in December 1985. Many of the craters have standing water within them, which indicates that they extend below the groundwater table. Water samples were obtained from two of the craters by Ertec (1982) and analyzed for explosives content determination. Explosive compounds were not detected in the samples collected, however, lead (163 and 151 µg/liter) and arsenic (100 and 18 µg/liter)

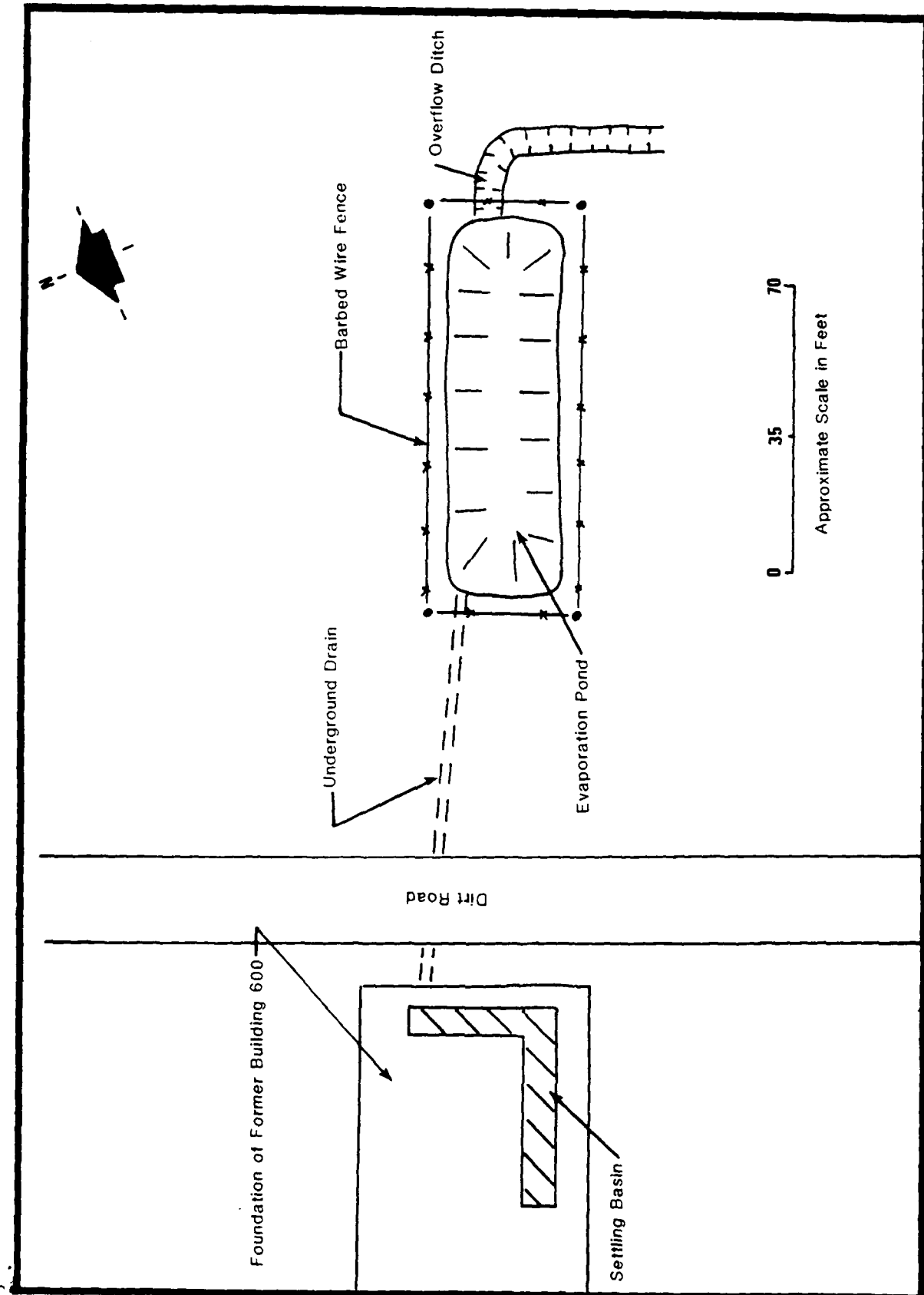


Figure 6-3. Site map of Bomb Washout Facility, S-TEAD.

were. Aqueous samples were also obtained from two of the craters during the PA/SI field effort. The results of the analysis are discussed in Section 8.4.

6.6 ACTIVE SANITARY LANDFILL

An active, unlined Sanitary Landfill is located near the northeast boundary of S-TEAD (Figure 6-1). Operation of the landfill began in 1976 and is conducted by the trench method (Tooele Army Depot 1981; USATHAMA 1979). There is no documentation on the types of wastes that have been disposed of in the facility or which indicates that hazardous materials were disposed at this facility. A potential for leachate development exists. However, because no major industrial operations have been conducted at S-TEAD, the negative water balance for this region and the great depth to groundwater (estimated to be 250-300 feet below the ground surface [Ertec 1982]), the potential impact to the underlying aquifer system is considered to be low.

6.7 ABANDONED SANITARY LANDFILL

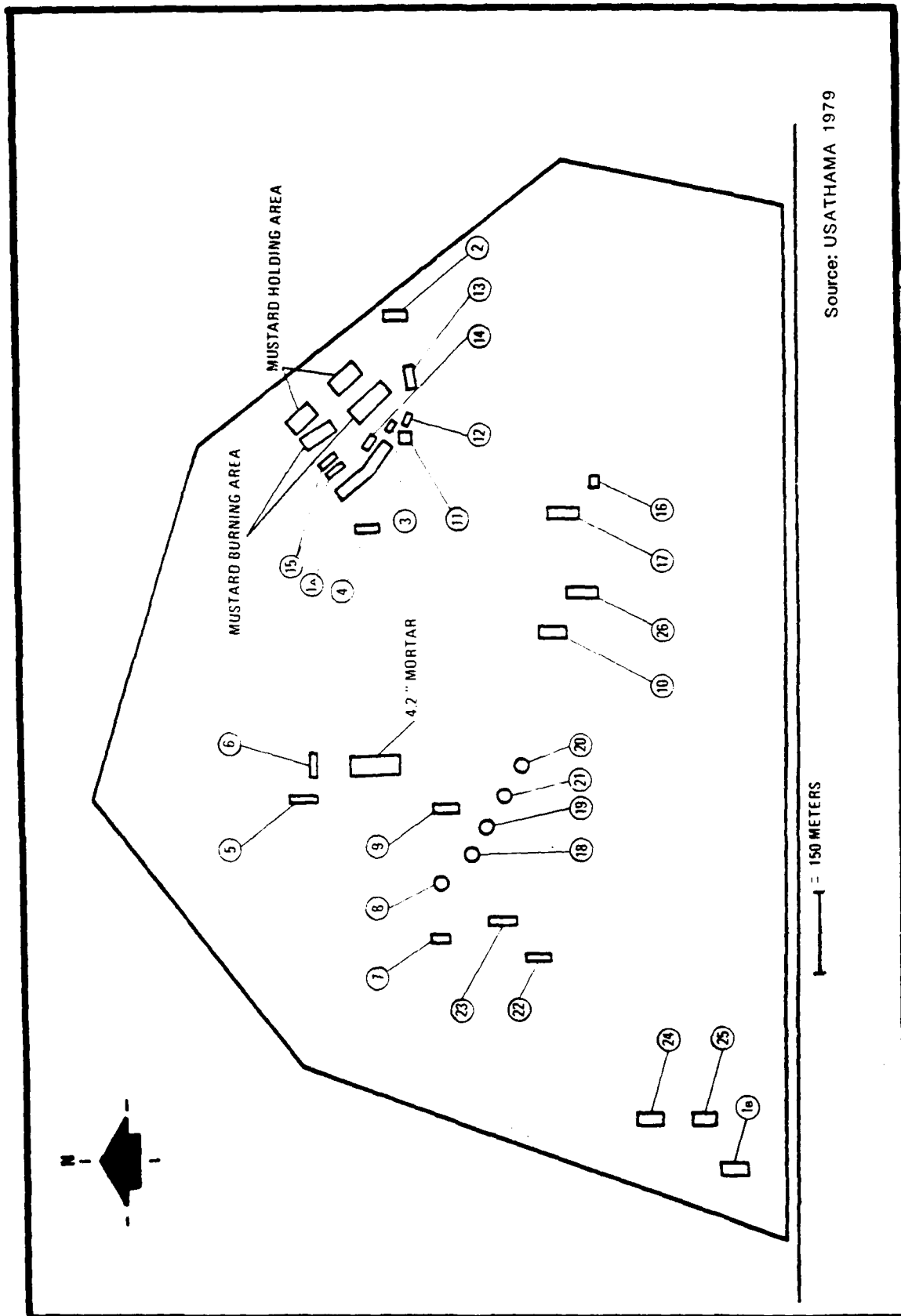
An Abandoned Sanitary Landfill, covering approximately 20 acres, is located approximately 2,000 feet west of the currently operating landfill (Figure 6-1). This facility is much smaller than the active landfill. EA was unable to obtain, through record searches and interviews, any information on the history of the landfill or on the types of waste buried at this site. A potential for leachate development exists, as the landfill is not known to be lined or capped with an impermeable membrane. However, because of the negative water balance for this region of Utah and the great depth to groundwater, the potential impact to the underlying aquifer system is considered to be low.

6.8 BURIAL PIT

A pit, located south of the southeast corner of the Mustard Holding Area, was observed to contain 1-gallon and 5-gallon cans and 208 1-liter drums (Figure 6-1). Several cans are marked "Decontaminating Agent, Noncorrosive," however, no markings were visible on the majority of cans and drums in this pit. This pit is not fenced or marked with warning signs.

6.9 CHEMICAL DEMILITARIZATION RANGE DISPOSAL PITS

Located on the eastern side of the Old Demilitarization Range are covered pits where chemical munitions (mustard bombs, white phosphorus grenades, incendiary bombs) were buried (Figures 6-1 and 6-4). Table 6-1 provides a listing of the pits and their contents. Most of the munitions buried in the pits were reportedly burned prior to burial. However, it is suspected that mustard munitions were disposed of in this area without burning. Also located within this area is a Mortar Pit containing



Source: USATHAMA 1979

Figure 6-4. Documented burial sites in the Chemical Demilitarization Range, S-TEAD.

TABLE 6-1 CONTENTS OF DOCUMENTED BURIAL SITES IN THE CHEMICAL
DEMILITARIZATION RANGE, S-TEAD

Pit Number	Contents
1a	M70 Mustard Bombs
1b	Mustard Bombs, M4A2 Smoke Pots, White Phosphorus grenades, trash
2	Thermite
3	Smoke Pots
4	M20 Bomb Clusters
5	Smoke Pots
6	Smoke Pots
7	Smoke Pots
8	M50XA3 Bombs
9	Smoke Pots
10	Thermite
11	Smoke Pots
12	Smoke Pots
13	M70 Mustard Bombs, one German Tabun Gas Bomb
14	M70 Mustard Bombs
15	M70 Mustard Bombs
16	M70 Mustard Bombs
17	M50XA3 Bombs
18	M50XA3 Bombs
19	M50XA3 Bombs
20	M50XA3 Bombs
21	M50XA3 Bombs
22	M70 Mustard and M47 Bombs
23	M70 Mustard Bombs
24	Trash Pit
25	Boosters
26	"Poison Gas" (probably mustard)

NOTE: See Figure 6-4 for pit location.

Source: USATHAMA 1979.

approximately 59,000 empty projectiles. In addition to these known pits, more than 70 other pits, trenches, and disturbed areas (whose contents are unknown) are visible in EPIC aerial photographs of this site.

6.10 WINDROW AREA

Located north of the Old Demilitarization Range are two long piles, approximately 0.25 miles in length, of scrap metal known as the Windrows (Figure 6-1). Clusterbombs, hangers, nose-plates, tail sections of cluster bombs, and fire bomb casings with M50-type thermite bombs are found throughout the Windrows. Most of the M-50 bombs are inert, however, many of the bombs still have live explosive X-charges in them (USATHAMA 1979).

6.11 GRAVEL PIT

A dirt-covered pit, located immediately south of Storage Area 10 (Igloo Toxic Storage Area), and referred to as the Gravel Pit, is reported to contain M2 ignition cartridges, squibs, hand grenades, blasting caps, and M21 incendiary bomb clusters (Figure 6-1). This area may also contain smoke pots, TNT blocks, M74 incendiary bombs, FS smoke (bottled), M19 incendiary bombs, and mustard. The contents of the Gravel Pit were not demilitarized before burial (USATHAMA 1979).

6.12 WAREHOUSE C4002 DEMILITARIZATION PIT

A pit located directly south of Storage Area 9, and directly beneath the present location of Warehouse C4002, was once used for demilitarization purposes (Figure 6-1). The nature of materials demilitarized at this site is not known. However, it is reported that explosive shells (4.2-inch projectiles) were exploded at this site in the 1940s. After the explosion, the crater was filled in and all contents were assumed to be demilitarized by the effects of the explosion. This site is not believed to contain hazardous materials (USATHAMA 1979).

6.13 MUNITIONS STORAGE AREAS 9 AND 10

Munitions Storage Areas 9 and 10, located in the northwest area of S-TEAD (Figure 6-1) have been consolidated into one large area within which all toxic agents are presently stored. The area is comprised of chemical munitions storage igloos which cover an area of approximately 1,155 acres. The site is an exclusion area and is secured by a chainlink fence. Documented information available on the history or operation of the area is classified. It is reported that Agents H, G, and VX in containers; and CAITS, M72, and M1 War Gas identification kits, are stored at this area (USATHAMA 1979).

6.14 OLD MUNITIONS STORAGE AREA 2

A former chemical munitions storage area, known as Storage Area 2, is located in the east-central portion of S-TEAD (Figure 6-1). The site encompasses an area of approximately 145 acres and is no longer used for the storage of toxic agents. Documented information on the history or

operation of this area is classified. It is reported that munitions, containers of Agents H, G, and VX, and CAITS, M72, and M1 War Gas identification kits, were stored at this area (USATHAMA 1979).

6.15 MUSTARD HOLDING AREA

Immediately adjacent to, and southwest of, Storage Area 2 is the Mustard Holding Area (Figure 6-1). In the northwest portion of this area, extensive contamination of surficial soils occurred from leakage of mustard contained in bombs (USATHAMA 1979). The site was decontaminated by treating with bleach and plowing the surface soil, however, this area may still be contaminated. The site is no longer used for holding toxic agents.

6.16 SOUTH AREA LABORATORY

The South Area Laboratory is located in Building S-541 in the eastern portion of S-TEAD (Figure 6-1). Analysis of agents stored at S-TEAD are conducted at this facility. Until December 1976, the agents processed were mustard agents (H, HD, HT), AC, CK, and CG. Waste materials and excess samples were burned at the demolition grounds. Toxic Agent GB has been processed since December 1976; toxic Agent VX has been processed since October 1978.

Current practice is to decontaminate the agent at the bench and to deliver it to a 1,000-gallon sump in which a sodium hydroxide concentration of at least 5 percent is maintained. Prior to the periodic removal of the sump contents, they are analyzed to ensure both the proper caustic concentration and the absence of the agent, before shipment to the CAMDS facility where they are dried to yield salts.

Other activities conducted at this laboratory include analysis of crankcase oil and antifreeze from the motor pool, and weekly bacterial analysis of the S-TEAD drinking water sources (USATHAMA 1979).

6.17 SEWAGE LAGOON

In 1980, a 250-foot x 250-foot Evaporation/Seepage Lagoon was constructed to handle domestic sewage from the S-TEAD Administrative and Warehouse Area (Figure 6-1). Sewage flows through a gravity-flow collection system to an Imhoff tank and then is discharged to the lagoons. The Imhoff tank has three 100,000-gallon chambers and is equipped with a pump for clean-out. The tank presently treats approximately 15,000 gallons of sewage per day. Periodically, sludge is removed from the Sewage Lagoon and Imhoff tank and buried on the installation. Prior to construction of the Sewage Lagoon, effluent was discharged directly to the soil. The Sewage Lagoon, which is located downgradient of the drinking water supply wells, is not considered to be a significant source of contamination.

7. FIELD PROGRAM

7.1 MONITORING PLAN DEVELOPMENT

The PA/SI Field Sampling Program was developed based on (1) a review of maps, aerial photographs, and available literature provided by USATHAMA, (2) information obtained from records searches and interviews with Depot personnel during the onsite visit, and (3) observations made during site surveys and the aerial flyover. A Field Sampling Design Plan was prepared for USATHAMA (EA 1986) which described S-TEAD sites considered to be potential sources of environmental contamination (Chapter 6). Of the sites addressed in the Field Sampling Design Plan, five sites were identified as presenting a significant potential for environmental contamination and designated for further investigation: (1) CAMDS diesel fuel spill(s), (2) CAMDS boiler blowdown discharge, (3) the Bomb Washout Pond, (4) Shower/Laundry Effluent Holding Ponds, and (5) the Explosion Craters in the Old Demilitarization Range. The quality of groundwater on a Depot-wide basis was also evaluated. A field sampling and analysis program was developed for each of these sites to provide an adequate analytical database to evaluate the existence of contamination, if any, and to provide a preliminary evaluation of contaminant movement, if appropriate. The field effort involved installation of groundwater monitoring wells and sampling/analysis of groundwater, surface water, wastewater, soil, and sediment.

7.2 MONITORING PROGRAM IMPLEMENTATION

7.2.1 Pre-Drilling/Sampling Analysis

Prior to initiating the well installation and sampling and analysis programs, aqueous samples were collected and analyzed from Supply Well No. 3 (N-TEAD) and No. 2 (S-TEAD). Sampling was performed on 17 January 1986. The results of chemical analysis are provided in Appendix II-A. Supply Well No. 2 was designated as the drilling water source and as the water supply for decontamination of drilling and sampling equipment for the S-TEAD field program (Figure 3-5). However, S-TEAD Supply Well No. 2 could not be assessed during the drilling program due to road repair activities at the entrance to the well site. Consequently, decontamination water for the S-TEAD field program was obtained from Well No. 3 at N-TEAD. A Pre-drilling Site Visit was then performed from 19 to 23 May 1986. Activities conducted during the site visit included: (1) obtained water level measurements at existing S-TEAD monitoring wells (Section 3.3) to determine the prevailing direction of groundwater movement and to facilitate selection of final well locations, (2) selected and staked monitoring well locations, (3) staked soil sampling locations, and (4) arranged and coordinated field activities with Depot personnel.

7.2.2 Monitoring Well Installation Program

Well installation was initiated at S-TEAD on 1 July 1986. Borehole drilling and well installation was conducted under subcontract by Sergeant, Hauskins, and Beckwith, Inc. (auger drilling) and Lang

Exploratory Drilling (air and hydraulic rotary drilling) of Salt Lake City, Utah. All well drilling and installation activities were supervised by an EA geologist.

A total of four monitoring wells were installed at S-TEAD. One well (SBR-1) was installed at the north perimeter of S-TEAD (Figure 3-5) for the purpose of obtaining background groundwater quality data, and three shallow wells (CAM-1, CAM-2, and CAM-3) were installed within the CAMDS Facility to evaluate the existence of a diesel fuel plume at the site (Figure 8-1). Well construction data for each well is summarized in Table 7-1. Completion diagrams, boring logs, and development logs for the wells are provided in Appendix II-B. The following sections present the methods, procedures, and materials that were used for installing the monitoring wells.

7.2.2.1 Background Monitoring Well

The actual depth to the aquifers and the subsurface stratigraphy at the background well location was not known prior to implementation of the field program due to the lack of existing wells within close proximity. In order to accurately define the depth to the prevailing water table aquifer and the stratigraphy at the proposed well site, an exploratory boring was performed prior to monitoring well installation, using dual tube, air rotary drilling methods. A Drilltech, D40K, top-head drive drill rig and a Sullair screw air compressor (rated at 750 cfm at 250 psi) was used for borehole drilling. A new air-line, oil filter was installed on the air compressor prior to borehole drilling and was changed per the manufacturer's recommendations during operation.

Borehole drilling was performed using 4-1/2-inch OD drill pipe with a 2-1/2-inch inner tube (which produced a borehole approximately 5 inches in diameter). Cuttings were monitored continuously during exploratory borehole drilling. In addition, a cutting sample was obtained at 5-foot depth intervals, and at every change in lithology, by the supervisory geologist and logged in accordance with USATHAMA (1983) requirements. Representative samples from each 5-foot depth interval were placed in half- or one-pint glass jars with air-tight, screw-type lids (canning jars).

Upon entering the aquifer, the water level was allowed to stabilize and a water level measurement was obtained (through the inner drill stem). The borehole was then abandoned in accordance with USATHAMA and State of Utah requirements. This was accomplished by filling the borehole with grout during drill pipe removal (i.e., fluids injected through drill pipe).

A monitoring well was then drilled and installed using hydraulic rotary drilling methods, approximately 25 feet (in a hydraulically upgradient direction) away from the exploratory borehole. An 8- to 10-inch borehole was drilled to the targeted depth (determined from exploratory borehole drilling) using hydraulic rotary drilling methods. Water from the approved water source and high-yield bentonite were the only drilling fluids used during borehole drilling. The use of bentonite was minimized near the projected screened interval. Down-hole gamma and resistivity

TABLE 7-1 DRILLING/WELL CONSTRUCTION SUMMARY, S-TEAD

<u>Bore/ Well</u>	<u>PVC Casing Diameter (inches)</u>	<u>Drilling Method</u>	<u>Finished Depth (ft BLS)</u>	<u>Screened Interval (ft BLS)</u>	<u>Water Level (ft BLS)</u>	<u>Ground Elevation (ft)</u>
CAM-1	2.0	Auger	21.6	5.6 - 21.6	8.86	5,038.90
CAM-2	2.0	Auger	23.5	5.5 - 23.5	9.08	5,039.52
CAM-3	2.0	Auger	20.5	5.5 - 20.5	8.86	5,039.90
SBR-1	5.0	Hydraulic Rotary	148.5	108.5 - 148.5	119.41	5,226.82

NOTE: BLS = below land surface.

logging was performed following the completion of borehole drilling to obtain additional stratigraphic information. Down-hole logging was performed by Strata Data of Denver, Colorado under subcontract with EA.

Following the completion of down-hole gamma/resistivity logging, well installation was accomplished through the open borehole. The assembled well was lowered down the borehole to the targeted depth. The drilling fluid in the borehole was greatly thinned and a clean silica sand back-fill installed to 5 feet above the top of the screen. A 5-foot thick layer of bentonite pellets was applied to the top of the sand pack and allowed to hydrate. A 1-inch tremie pipe was then lowered down the borehole to just above the bentonite seal and grout tremied down until it extended to the surface. The tremie pipe was then pulled and additional grout added until it extended to land surface. The grout mixture consisted of water, bentonite, and Portland cement. For every 10 gallons of water, a 94-lb bag of cement and 5 lbs of bentonite were mixed. The grout mixture was allowed to set at least 48 hours before well development.

The well was constructed of 5-inch diameter schedule 40 PVC, with threaded joints, and contained 40 feet of bottom plugged PVC screen (installed 10 feet above and 30 feet below the water table). The well riser was extended to 2 feet above land surface (ALS) and was fitted with an over-sized PVC cap with metal eye bolt to facilitate removal. A protective steel surface casing, complete with cap, lock, and drainage vent was installed over the riser pipe. The steel casing was painted a fluorescent orange for ease of visibility. Three metal picket guard posts were placed 4 feet radially from the surface casing and strung with 3-strand barb wire. A well completion diagram and boring log are provided in Appendix II-B.

7.2.2.2 CAMDS Wells

EA installed three shallow monitoring wells around the diesel fuel storage tank area at CAMDS to evaluate the potential existence of a diesel fuel plume at the site. The location of the wells are shown on Figure 8-1. A summary of well completion data for the wells is provided in Table 7-1. Final well placement was determined in the field following identification of underground fuel lines and other underground utilities.

The well borings were performed using a truck-mounted auger drill rig equipped with 10-inch outside diameter (OD), 6-inch inside diameter (ID) hollow-stem augers. Split-spoon samples were taken at 5-foot intervals and at every change in lithology in order to characterize the subsurface environment and to accurately identify the depth to the water table. Auger cuttings were monitored continuously. Drilling proceeded without the use of water to avoid the introduction of foreign materials into the aquifer. The procedures used were as follows:

1. Set-up over the stake, and plumb the rig.
2. Advanced the auger hole to 5-feet BLS with the hollow stem auger plugged.

3. The auger plug was removed and a 2-foot split-spoon sample was obtained.
4. Replaced the auger plug and advanced another 5-foot auger flight.
5. Repeated Steps 3 and 4 until the prevailing shallow groundwater table aquifer was identified.
6. After the water table was encountered, the water level was allowed to stabilize for at least 10 minutes and its depth (in feet BLS) measured before continuing.
7. Once the depth to the prevailing water table was determined, the borehole was advanced into the aquifer by repeating Steps 3 and 4 until the top of the bottom confining clay unit was encountered.

Well installation was accomplished through in-place, hollow-stem augers. Once the augers had been advanced to the finished depth and the auger plug removed, the assembled screen and riser were lowered down the hollow-stem and the augers raised not more than 2.5 feet. Well gravel (clean silica sand backfill) was added, and its level sounded. This procedure was repeated until the sand pack extended to 2-2.5 feet above the top of the screen. The augers were then raised approximately 2 feet above the top of the sand pack and a 1-foot layer of bentonite was added, and allowed to hydrate by adding approximately 1 gal of water from the approved water source, to form a seal over the sand pack. A 1-inch tremie pipe was then lowered down the annulus between the casing and augers to just above the bentonite seal and grout tremied down until grout extended to the surface. The tremie pipe and augers were then pulled and additional grout added until it extended to land surface. The grout mixture consisted of water, bentonite, and Portland cement (10 gallons of water, one 94-lb bag of cement, and 5 lbs of bentonite). The grout mixture was allowed to set at least 48 hours before well development.

Each monitoring well was constructed of Schedule 40, threaded flush joint PVC, 2-inch ID, and contained a bottom plugged PVC screen (10 slots/inch at 0.010 inches/slot). The entire saturated interval was screened to the bottom of the confining clay layer. Well risers were extended 2 feet ALS and were fitted with an over-sized PVC cap. A 6-inch diameter protective steel surface casing, complete with cap, lock, and drainage vent was installed over the riser pipe. The steel casing measured 5 feet in length, extended 2.5 feet ALS and BLS, and was painted orange for ease of visibility. As an added protective measure, three 3-inch diameter steel guard posts were installed 4 feet radially from the surface casing of each well. A completion diagram and boring log for each of the wells is provided in Appendix II-B.

7.2.2.3 Decontamination Procedures

Before drilling the first well, between drilling of wells, and after drilling the final well, all drilling, measuring, and sampling equipment that contacted potentially contaminated soils or water was cleaned to prevent cross-contamination. This was accomplished by placing equipment

on blocks and steam cleaning and rinsing with water from the approved source. All pumps, pipes, hoses, and other equipment that could not be internally scrubbed were flushed with approved water.

7.2.2.4 Well Development

The development of monitoring wells was performed as soon as practical after well installation (but not sooner than 48 consecutive hours after internal grout collar placement) and was accomplished in accordance with Section III.E. of USATHAMA's "Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports," dated May 1983. Well Development logs for each well are provided in Appendix II-B.

7.2.2.5 Surveying

The coordinates and elevation of each well were surveyed by Forsgren-Perkins Engineering of Salt Lake City, Utah, under subcontract with EA. Specifications in Paragraph III.G of the "Geotechnical Requirements" were followed. In addition, two existing wells (S-1 and H-6) were resurveyed (tied-in) to provide a uniform database for Depot monitoring wells. Table 7-2 provides a list of the elevations and horizontal coordinates for each of the wells. Surveying notes and calculations are provided in Appendix II-C.

7.2.3 Field Sampling/Analysis Program

The sampling program at TEAD was initiated on 18 February 1987. The sampling phase of the field program was initiated approximately 22 weeks after the wells had been installed and developed because of delayed laboratory certification. Table 7-3 provides a summary of the planned and implemented Sampling/Analytical Program for S-TEAD. The sampling procedures and protocol implemented are discussed in the following sections.

7.2.3.1 Groundwater Sampling

The Groundwater Sampling Program was designed to provide data on the groundwater quality both upgradient and downgradient of each site. The protocol followed for collection of groundwater samples included:

- . Physical inspection and observation
- . Water level determination
- . Well purging
- . Field analyses
- . Groundwater sampling
- . Sample handling

Physical Inspection

Upon arrival at each well, the condition of the well and surrounding area was noted. This included, but was not limited to,

TABLE 7-2 SUMMARY OF SURVEY DATA FOR NEWLY INSTALLED WELLS, S-TEAD

<u>Well Number</u>	<u>State Plane Coordinates</u>		<u>Elevation (ft above MSL) Top of PVC Casing</u>
	<u>N-S</u>	<u>E-W</u>	
SBR-1	729,974.60	1,759,763.94	5,229.38
CAM-1	712,571.00	1,758,154.47	5,041.44
CAM-2	712,746.42	1,758,116.12	5,042.04
CAM-3	712,673.64	1,758,186.49	5,042.53

TABLE 7-3 SUMMARY OF PLANNED AND IMPLEMENTED PA/SI FIELD SAMPLING PROGRAM
CONDUCTED AT S-TEAD, 17 FEBRUARY - 4 MARCH 1987

<u>Sample Location</u>	<u>Aqueous Samples</u>		<u>Soil Samples</u>		<u>Analyses</u>
	<u>Planned</u>	<u>Actual</u>	<u>Planned</u>	<u>Actual</u>	
Wells					
Background Well	1	1	0	0	A-H
Existing Monitoring Wells	11	11	0	0	A-H
CAMDS Wells ^(a)	3	1	0	0	A-H
CAMDS Runoff	1	1	0	0	A-H
Explosion Craters	2	2	0	0	A-H
Bomb Washout Pond					
Discrete Samples ^(b)	0	0	30	4	E, G
Composite Samples	0	0	5	0	N/A
Laundry Pond ^(c)	0	0	0	1	E, G
	—	—	—	—	
Total	18	16	35	5	

(a) The other two wells at CAMDS had floating product on the water table surface. Did not collect samples due to presence of floating product.

(b) Compositing of 30 discrete samples was originally planned, however, due to the small size of the Bomb Washout Pond, 4 discrete samples were collected for analysis.

(c) The existence of the Laundry Pond was not known before performance of Field Sampling Plan. It was decided to collect one surficial soil sample from this site, and 4 samples from the Bomb Washout Pond.

Analyses Key:

A - Metals (total)
B - Base/Neutral/Acid Extractable Organics
C - Volatile Organics
D - Inorganics

E - Explosives
F - Agent Indicators
G - NO₂+NO₃-Nitrogen
H - Radionuclides

TABLE 7-3 (Cont.)

A - Metals

Antimony
 Arsenic
 Beryllium
 Cadmium
 Chromium
 Copper
 Lead
 Mercury
 Nickel
 Selenium
 Silver
 Thallium
 Zinc
 Cyanides - Total

B - Base/Neutral and Acid Extractables(b)

N-Nitrosodimethylamine
 Bis(2-Chloroethyl)ether
 1,3-Dichlorobenzene
 1,4-Dichlorobenzene
 1,2-Dichlorobenzene
 Bis(2-Chloroisopropyl)ether
 Hexachloroethane
 N-nitroso-di-n-propylamine
 Nitrobenzene
 Isophorone
 Bis(2-chloroethoxy)methane
 1,2,4-Trichlorobenzene
 Napthalene
 Hexachlorobutadiene
 Hexachlorobutadiene
 2-Chloronaphthalene
 Acenaphthylene
 Dimethyl phthalate
 2,6-Dinitrotoluene
 Acenaphthene
 2,4-Dinitrotoluene
 Fluorine
 Diethyl phthalate
 4-Chlorophenyl phenyl ether
 N-Nitrosodiphenylamine
 1,2-Diphenylhydrazine
 4-Bromophenyl phenyl ether
 Hexachlorobenzene
 Phenanthrene
 Anthracene
 Di-n-butyl phthalate
 Fluranthene

B - Base/Neutral and acid Extracables (Cont.)

Benzidine
 Pyrene
 Butyl benzyl phthalate
 Benzo(a)anthracene
 3,3-Dichlorobenzidine
 Chrysene
 Bis(2-ethylhexyl)phthalate
 Bi-n-octyl phthalate
 Benzo(a)pyrene
 Indeno(1,2,3-cd)pyrene
 Dibenzo(a,h)anthracene
 Benzo(g,h,i)perylene
 Benzo(b)fluoranthene+
 benzo(k)fluoranthene
 Phenol
 2-Chlorophenol
 2-Nitrophenol
 2,4-Dimethylphenol
 2,4-Dichlorophenol
 p-Chloro-m-cresol
 2,4,6-Trichlorophenol
 2,4-Dinitrophenol
 4-Nitrophenol
 4,6-Dinitro-o-cresol
 Pentachlorophenol

C - Volatile Organics(a)

Acrolein
 Acrylonitrile
 Benzene
 Carbon tetrachloride
 1,2-Dichloroethane
 1,1,1-Trichloroethane
 1,1-Dichloroethane
 1,1,2-Trichloroethane
 1,1,2,2-Tetrachloroethane
 Chloroethane
 2-Chloroethylvinyl ether
 Chloroform
 1,1-Dichloroethene
 trans-1,2-Dichloroethene
 1,2-Dichloropropane
 1,3-Dichloropropene
 Ethylbenzene
 Methylene chloride
 Chloromethane
 Bromomethane
 Bromoform
 Bromodichloromethane

TABLE 7-3 (Cont.)

C - Volatile Organics (Cont.)

Fluorotrichloromethane
Chlorodibromomethane
Tetrachloroethene
Toluene
Trichloroethene
Vinyl chloride
Total Xylenes

D - Inorganics

Chloride
Fluoride
Bromide
Orthophosphate
Sodium
Sulfate

E - Explosives

RDX
Nitrobenzene
1,3-Dinitrobenzene
1,3,5-Trinitrobenzene
2,4-Dinitrotoluene
2,6-Dinitrotoluene
2,4,6-Trinitrotoluene
HMX
Tetryl

F - Agent Indicators

Thiodiglycol
p-Chlorophenylmethylsulfone
p-Chlorophenylmethylsulfoxide
p-Chlorophenylmethylsulfide
Diisopropylmethylphosphonate

G - Nitrogen

Nitrite
Nitrate

H - Radionuclides

Gross Alpha
Gross Beta

(a) EPA Method 624 by GC/MS.

(b) EPA Method 625 by GC/MS.

NOTE: All above analyses were performed for all soil and water samples unless otherwise specified. If analysis were not listed on the summary tables provided in Chapter 8, all values were below the limits of detection.

- . Security

- Is well locked?
- Is there evidence of tampering?
- Is there evidence of physical damage?

- . Well Integrity

- Evidence of breakage or heaving of concrete seal, if present
- Evidence of surface infiltration.

The information gathered was recorded in a bound field notebook for inclusion in the field sampling report.

Water Level Measurement

After the physical inspection, static-water levels were determined prior to initiation of purging and sampling activities. All water level determinations were made to the nearest 0.01 feet using electronic sounders. The procedure involved slowly lowering the precleaned sounder probe into the well until the indicator (light or meter) was activated. After an indication of water penetration was achieved, the probe was slowly raised and lowered until the indicator accurately registered the water surface which was referenced to the top of the well casing. The measured water level was recorded in a field notebook. A summary of water level measurements obtained in April 1986 and February 1987 is presented in Table 3-2.

Field Measurements

Specific conductivity, temperature, and pH measurements were conducted on the first volume of groundwater purged at all monitoring wells sampled. Sample collection and analysis were conducted as described in the Installation Restoration Program (IRP) Quality Assurance Program Plan (EA 1986). Field measurements obtained during the PA/SI Field Program are presented in Appendix II-D.

Well Purging

Prior to sample acquisition, each well was purged to ensure collection of a representative groundwater sample. Well purging was performed by Ground Water Sampling, Inc. of Englewood, Colorado under subcontract to EA, and was supervised by EA personnel. All wells were purged using a submersible pump, with the exception of Well No. CAM-3, where a bottom-filling bailer was used. Purging continued until five casing volumes were removed or until the well was dry.

During purging, the pump was lowered into the well until it penetrated the water surface, at which time it was energized. The pump was lowered slowly through the water column to the bottom of the well. The pump was then raised several feet above the bottom of the well and held static for the duration of purging. The purging rate was determined by recording the time required to fill a 5-gallon pail. The volume to be purged (five static casing volumes) was divided by the pumping rate in gallons per

minute (gpm) to determine the required pumping duration. The pump's discharge was directed sufficiently downgradient at all times to avoid rapid re-infiltration. (A foot valve was installed in the pumps to preclude cross-contamination.)

When a well dewatered prior to evacuation of the required volume, the well was allowed 15 minutes to recover and pumping re-initiated. If the well again dewatered, the pump was removed from the well and the volume purged recorded.

Bailer and Pump Cleansing

To avoid cross-contamination, the pump and/or bailer used in purging was cleaned thoroughly between wells using the approved water source. Purging and sampling were conducted beginning with the least potentially contaminated well and finishing with the most potentially contaminated (the degree of contamination was based on existing available information).

Sample Collection

Only sampling gear that had been cleaned in accordance with the Quality Assurance Program Plan (EA 1986) was used. Sampling material was protected from contacting the ground by spreading a clean plastic protective cover around each well prior to sampling. New protective covers were used for each well. Sampling personnel washed their hands between wells to avoid cross-contamination. Disposable gloves were used for handling sampling gear which minimized the potential for cross-contamination and also protected personnel from contacting contaminants that may have been present in the samples.

Groundwater sampling was accomplished with either a clean, bottom-filling Teflon bailer, submersible pump, and/or peristaltic pump. When a bailer was used for sampling, only clean bottom-filling Teflon bailers were used and a clean, dedicated piece of nylon line was attached to the bailer and the bailer was lowered into the well. Care was exercised to ensure that the bailer and line did not contact the ground or other sources of contamination. The bailer was lowered into the well until it filled and was retrieved; the water was then discarded. This process was repeated three times. The bailer was then filled and the sample was transferred to the sample containers. When the pump was used, samples were placed directly into appropriate sampling containers (Table 7-4). Each container was first rinsed three times with excess sample water in both instances. Preservatives were added as described below. Samples for volatile organics were collected in a manner that minimizes aeration (peristaltic pump), and the containers were kept free of bubbles and headspace. After the containers were filled, they were labeled, and an entry was made on the Chain-of-Custody Form. The sample container was then placed immediately in a cooler on ice. All samples were shipped to the laboratory by air freight (i.e., overnight delivery).

TABLE 7-4 SAMPLE CONTAINERS, PRESERVATION, STORAGE, AND HOLDING TIMES

Parameter	Container (a)		Preservative (b)		Maximum Holding Time for all Matrices
	Water	Soil	Water	Soil	
INORGANIC TESTS					
Bromide	P	G	None Required	None Required	28 days
Chloride	P	G	None Required	None Required	28 days
Cyanide, Total and Amenable in Chlorination	P	G	Cool, 4° C NaOH to pH >12 0.6 g Ascorbic Acid	Cool 4° C	14 days
Fluoride	P	G	None Required	None Required	28 days
Metals					
Chromium VI	P	G	Cool, 4° C	Cool, 4° C	24 hours
Mercury	P	G	HNO ₃ to pH <2	Cool, 4° C	28 days
Others	P	G	HNO ₃ to pH <2	Cool 4° C	6 months
Nitrate + Nitrite	P	G	Cool, 4° C H ₂ SO ₄ to pH <2	Cool, 4° C	28 days
Oil and Grease	P	G	Cool, 4° C H ₂ SO ₄ to pH <2	Cool, 4° C	28 days
Orthophosphate	P	G	Filter Immediately Cool, 4° C	Cool, 4° C	48 hours
Phenols	G	G	Cool, 4° C H ₂ SO ₄ to pH <2	Cool, 4° C	28 days
Phosphorous (Elemental)	G	G	Cool, 4° C	Cool, 4° C	48 hours
Sulfate	P	G	Cool, 4° C	Cool, 4° C	28 days
Surfactants	P	G	Cool, 4° C	Cool, 4° C	48 hours

TABLE 7-4 (Cont.)

TABLE 1.4 (Contd.)

Parameter	Container (a)		Preservative (b)		Maximum Holding Time for all Matrices
	Water	Soil	Water	Soil	
ORGANIC TESTS					
Chlorinated Hydrocarbons	G	G	Cool, 4° C	Cool, 4° C	7 days until extraction 40 days after extraction
Haloethers	G	G	Cool, 4° C 0.008% Na ₂ S ₂ O ₃	Cool, 4° C	7 days until extraction 40 days after extraction
Nitroaromatics and Isophorone	G	G	Cool, 4° C Store in Dark	Cool, 4° C Store in Dark	7 days until extraction 40 days after extraction
PCBs	G	G	Cool, 4° C	Cool, 4° C	7 days until extraction 40 days after extraction
Pesticides	G	G	Cool, 4° C pH 5-9	Cool, 4° C	7 days until extraction 40 days after extraction
Phenols	G	G	Cool, 4° C 0.008% Na ₂ S ₂ O ₃	Cool, 4° C	7 days until extraction 40 days after extraction
Phthalate Esters	G	G	Cool, 4° C	Cool, 4° C	7 days until extraction 40 days after extraction
Polynuclear Aromatic Hydrocarbons	G	G	Cool, 4° C 0.008% Na ₂ S ₂ O ₃ Store in Dark	Cool, 4° C Store in Dark	7 days until extraction 40 days after extraction
Purgeable Aromatics	S	S	Cool, 4° C 0.008% Na ₂ S ₂ O ₃ HCl to pH 2-3	Cool, 4° C	14 days

(a) P = Polyethylene

G = Amber Glass with Teflon-lined cap.

S = Glass Vial with Teflon-lined septum cap.

(b) All samples cooled to 4° C.

Sample Filtration

Aqueous samples collected for determination of sulfate and orthophosphate were filtered prior to the addition of preservatives. Sample filtration was conducted using a 0.45- μ filter. Sample bottles designated for sulfate and orthophosphate analysis were rinsed with the filtrate three times before collecting the final filtered sample.

Addition of Preservative

Preservatives appropriate for the analysis to be performed on each sample were added as each sample was collected. The sample containers and appropriate preservatives used at Tooele Army Depot are identified in Table 7-4.

7.2.3.2 Soil Sampling

Soil samples were collected at two areas, S-TEAD Bomb Washout Pond and Shower/Laundry Effluent Pond (Table 7-3). Prior to sampling, surface vegetation, rocks, pebbles, leaves, twigs, and debris were removed from the area. Soil samples were collected with a clean stainless steel hand-driven corer or hand trowel. The depth of soil sample collection was site dependent and is presented in Chapter 8.

As samples were collected, they were placed in containers of appropriate composition for the parameters to be analyzed. This included laboratory-cleaned glass containers with Teflon-backed closures for organic parameters, and linear polyethylene (Nalgene) containers for trace metals and cyanide. Samples for volatile organics were placed in wide-mouth, amber glass bottles which were sealed with a Teflon septum. As each sample was collected, the containers were labeled, security sealed, and placed on wet ice in secured coolers. No preservatives were added to soil samples. As each sample was collected, the location was flagged, the security seal number recorded in the field notebook, pertinent observations (i.e., vegetation stress, depth of soil) noted and recorded, and entries made on the Chain-of-Custody Form. The samples were then shipped to EA's laboratory within appropriate holding times.

Equipment used for collection of soil samples (e.g., hand trowels, soil corers) was cleaned after obtaining each sample by scrubbing and rinsing three times with USATHAMA-approved water.

7.2.3.3 Quality Assurance/Quality Control

Sample collection and laboratory analysis were conducted in accordance with the methods and procedures detailed in the Field Sampling Design and Installation Restoration Program (IRP) Quality Assurance Program Plan (EA 1986), codified, and entered into the Installation Restoration Data Management System (Section 7.3).

Field sampling was performed following strict decontamination, sample handling, packaging, and chain of custody procedures. A trip blank was also included in the overall sampling program as a field quality control check. The trip blank analytical results are summarized in Table 7-5.

TABLE 7-5 TRIP BLANK ANALYTICAL RESULTS FOR S-TEAD PA/SI

<u>Parameter (µg/L)</u>	<u>Trip Blank</u>
PCBs	
Aroclor 1016	<1.3
Aroclor 1260	<2.6
PESTICIDES	
Aldrin	<0.15
Alpha-BHC	<0.17
Gamma-BHC	<0.13
4,4'-DDD	<0.11
4,4'-DDE	<0.23
4,4'-DDT	<0.27
Dieldrin	<0.17
Endrin	<0.35
Heptachlor	<0.16
Malathion	ND
Bromacil	ND
Chlordane	ND
VOLATILES	
Trichloroethene	<2
SEMIVOLATILES	
Phenol	5
AGENT INDICATORS	
Thiodiglycol	<720
p-Chlorophenylmethylsulfide	<43.4
p-Chlorophenylmethylsulfoxide	<79.6
p-Chlorophenylmethylsulfone	<30.8
Diisopropylmethylphosphonate	<23.3
EXPLOSIVES	
HMX	<5.1
RDX	<4.2
Nitrobenzene	ND
1,3-Dinitrobenzene	<9.1
1,3,5 Trinitrobenzene	<5.8
2,4-DNT	<2.2
2,6-DNT	<5.7
2,4,6-TNT	<6.3
Tetryl	<4.4

TABLE 7-5 (Cont.)

<u>Parameter (ug/L)</u>	<u>Trip Blank</u>
METALS	
Antimony	<7.0
Arsenic	<2.4
Barium	<5*
Beryllium	<0.83
Cadmium	<12
Chromium	<11
Copper	<21
Lead	<1.5
Mercury	<1.1
Nickel	<65
Selenium	<2.5
Silver	<0.14
Sodium	<400
Thallium	<1.7
Zinc	<43
ORGANICS	
Phenol	<870
Surfactants	60
INORGANICS	
Bromide	<240
Chloride	<5,000
Cyanide, Total	<30
Fluoride	400
Nitrate + Nitrite Nitrogen	90
Orthophosphate	<57
Sulfate	5,000
EA Sample Number	1682

NOTE: ND indicates a compound not assigned a certified reporting limit (CRL) and not found above the analytical detection limit.

* Analytical detection limit is reported as it is greater than the certified reporting limit (CRL).

Prior to sample analysis, laboratory spikes and blanks were run to statistically establish the lowest sample concentration which would be reported. This concentration is the Certified Reporting Limit (CRL). For USATHAMA IR projects, CRLs are determined by using the USATHAMA program with 90 percent confidence limits. This CRL is associated with the entire method and reflects all sample preparation and measurement steps. The CRLs for the TEAD PA/SI are presented in Appendix II-E.

7.3 DATA MANAGEMENT

All required data from the installation of wells and borings, sampling of surface water, groundwater, soils and sediment, and chemical analyses were entered into the computerized Installation Restoration Data Management System (IRDMS). The following types of data were entered into IRDMS by EA data management personnel:

<u>Data Type</u>	<u>Data File</u>
Geotechnical - Map location	GMA
Geotechnical - Field drilling	GFD
Geotechnical - Well construction	GWC
Geotechnical - Groundwater stabilization	GGs
Chemistry - Groundwater	CGW
Chemistry - Soil	CSO

The IRDMS requires that the first data to be entered for a site are the map location data. Map location data were obtained from the surveyor's report, which included a detailed map. EA data management personnel entered information from this report and map directly into EA's PC-AT. After checking transmission acceptance and merging of the map location datafile into the IRDMS, EA proceeded with entry of other data types.

Data from the field program was recorded on EA field log sheets. Site types and site I.D. codes were assigned and the field log sheets were transcribed to coding sheets in the Level 1 file format. The coding sheets were used as the basis for data entry onto Level 1 files via IRDMS. Field drilling, well construction, and groundwater stabilization data were transcribed from the logs, coded, and entered on IRDMS data sheets designed for each specific data type. EA chemistry and data management personnel similarly coded the analytical chemistry results onto IRDMS chemistry data sheets.

Data management personnel then entered the coded project data on EA's PC-AT using government-furnished software. After entry at EA, data were classed as Level 1 data. These Level 1 data were checked at EA record-by-record. Once data passed this individual record check, groups of records were globally checked. EA data management personnel edited the data and corrected any errors uncovered in either edit check. When data-

sets passed both edit checks at EA, they were transmitted to USATHAMA where they were temporarily stored as Level 2 data. Data were transmitted to USATHAMA using a 1200-baud mode and computer communications software. PRI, Inc., the government contractor maintaining the IRDMS, repeated both the individual record check and the global check. When datasets passed these checks, PRI merged these data into the IRDMS. At this point, the data were final or Level 3 data.

After acceptance of all project data into the IRDMS, IRDMS programs were used to produce the data summaries and tables which are provided in Appendix II-E.

8. ENVIRONMENTAL CONTAMINATION INVESTIGATIONS

8.1 CAMDS FACILITY

8.1.1 Site Location and History

The CAMDS Facility is located in the southwestern area of S-TEAD. The Facility consists of a number of buildings within an area of approximately 600 feet X 1,000 feet. The entire complex is enclosed by a double-tier chainlink fence. The general location of the Facility is shown on Figure 6-1. Figure 6-2 is a site map of CAMDS.

CAMDS, which became operational in 1979, is a prototype facility designed to demilitarize a wide variety of chemical munitions and containers, and to detoxify chemical Agents GB, VX, and mustard. As of 10 July 1987, the following munitions and agents have been destroyed:

<u>Item</u>	<u>Quantity</u>
<u>Munitions</u>	
M55 GB Rockets	17,978 each
105 MM Projectiles	7,771 each
155 MM Projectiles	11,860 each
<u>Agents</u>	
Agent GB (Neutralization)	181,945 pounds
Agent GB (Incineration)	75,532 pounds
Agent VX (Incineration)	7,866 pounds

Prior to the later part of 1982, chemical agents were decontaminated (neutralized) by processing it with sodium hydroxide and other chemicals. A brine was formed during the decontamination process which was then dried, leaving a salt residue (Tooele Army Depot 1985a). Recently, the CAMDS Facility has been processing the Agent GB from chemical munitions. Since the later part of 1982, the agent has been destroyed by incineration. The only current source of brine is from the Pollution Abatement System. This brine has been shown to be variable in composition, depending upon agent type and source. However, both types of salt (from the Pollution Abatement System and chemically neutralized brines) have been determined to be hazardous waste due to the presence of small amounts of heavy metals, such as cadmium and lead, when tested for "Extraction Procedure Toxicity" as set forth by the U.S. EPA.

Waste pollution abatement salts are placed in 55-gallon fiber drum containers for disposal in a U.S. EPA-approved landfill. During the period of 24 August - 16 September 1984, 3,787 drums of salt were removed, transported, and stored in a U.S. EPA-approved disposal facility near Beatty, Nevada, which is operated by U.S. Ecology. On 29 July 1987, 1,470 drums of chemically neutralized salts were sent to an approved landfill, Envirosafe Services in Grandview, Idaho, for proper disposal. Prior to

their removal, the drums were stored in Building 403 in S-TEAD. All CAMDS activities are designed to operate with no significant environmental impact (Flam 1988).

There are three diesel fuel tanks, each with a capacity of 30,000 gallons, located within the western perimeter of the CAMDS Facility (Figure 6-2). An underground spill (line leak) of diesel fuel reportedly occurred at this site sometime between 1980 and 1985. The line leak went undetected for a period of time and an estimated 38,000 gallons of fuel were lost.

A documented diesel fuel spill occurred at CAMDS in January 1978 (USATHAMA 1979). Approximately 500 gallons of fuel was spilled on the ground surface and was reported to have been properly cleaned up in accordance with TEAD's Spill Prevention Control and Counter-Measure and Installation Spill Contingency Plan.

Boiler blowdown water and water used for cooling of life support compressors is discharged to the ground surface, where it then flows overland and ponds outside of the southern perimeter of the Facility (Figure 6-2). Discharge of water occurs on a continuous basis due to operation of life support compressors 24 hours/day. The standing water indicates that a water mound may exist at this site.

8.1.2 Site Characteristics

The CAMDS Facility is located in an isolated, open area of Rush Valley. The topography in the vicinity of the site is relatively flat; maximum site relief is about 8 feet from northeast to southwest. There are no naturally occurring perennial streams located near the site.

Soils within the CAMDS Facility area consist of firm-to-stiff silty clays which contain minor occasional random thin layers of silt to fine sand and occasional gravelly clays. The consistency of the clay subsoils increases from firm-to-stiff to stiff-to-hard at approximately 25 feet BLS. The clayey subsoils below about 10 feet commonly exhibit "blocky" fractures with openings on the order of .02-.036 inches wide and spaced at 1.5-2.0 inches (R&M Consultants, Inc. 1984).

Depth to shallow groundwater ranges from about 4 to 12 feet BLS depending upon seasonal conditions and topographic location within the Facility. In the immediate proximity of the fuel storage tanks, the shallow groundwater table occurs at an average depth of 9 feet BLS. R&M Consultants, Inc. (1984) reported that movement of the shallow groundwater is via small, closely-spaced open fractures within the clay subsoils. Groundwater flow through the unfractured portion of the clay subsoils is reportedly extremely slow. Persistent zones of higher permeability soils, such as sand layers, have not been encountered in the CAMDS Facility Area (R&M Consultants, Inc. 1984). The effective base of the aquifer is assumed to be at approximately 25 feet BLS as determined by a distinct increase in the hardness of the clayey subsoils at this depth. Elevations of the static water table measured in the CAMDS Facility Area indicates a southwest sloping surface at a gradient of 3:500 feet (R&M Consultants, Inc. 1984). Water level measurements obtained from wells installed at the diesel fuel spill site indicate a west-to-southwesterly flow direction and

a hydraulic gradient of 0.016; which is reasonably consistent with the reported local trend. The groundwater conditions at this site may be influenced by mounding of water at the south side of CAMDS where boiler blowdown water is discharged to the ground surface.

A drinking supply well was constructed at the CAMDS Facility in 1972 at a depth of 550 feet. The well produced a flow rate of 122 GPM (Tooele Army Depot 1985a). However, the well was removed from service due to excessive amounts of silt in the water.

8.1.3 Site Contamination Investigation

8.1.3.1 Diesel Fuel Spill Site

No subsurface environmental monitoring had been conducted at CAMDS prior to the PA/SI activities performed to determine the environmental impact of the diesel fuel spills. Due to the large volume of fuel oil released, this site was considered to present a potential source of groundwater and soil contamination. Three monitoring wells were installed in the immediate vicinity of the spill site to evaluate the existence of contamination in the shallow water table aquifer (Figure 8-1). Well construction information is detailed in Chapter 7 of this report.

Prior to purging, all three wells were inspected for the presence of floating product. Though the Final Field Sampling Design Plan (EA 1986) called for sampling of all installed wells, prior to initiating the Field Sampling/Analysis Program it was decided that wells containing floating product would not be sampled. Visible floating product and diesel fuel odor was apparent in Well Nos. CAM-1 and CAM-2 at the time of sampling. Therefore, only Well No. CAM-3 was sampled for determination of explosives, agent indicators, volatiles and semi-volatiles organics, metals, inorganics, and gross alpha/beta. The results of chemical analysis of the groundwater sample obtained from Well No. CAM-3 are summarized in Table 8-1.

As is indicated in Table 8-1, eight semi-volatile organic compounds were detected in the groundwater sample; naphthalene compounds were present at the highest concentrations (100-200 ppb). Benzene and ethylbenzene were also detected at concentration levels of 20 ppb and 6 ppb, respectively. The presence of these compounds is indicative of diesel fuel.

2,4,6-TNT was detected in the groundwater sample at a concentration of 14.2 ppb. The presence of this explosive compound in the sample is somewhat anomalous and could not be determined with reasonable certainty from available information. The CAMDS Facility is relatively new and provides for full explosive containment. As such, a potential source and pathway for explosives contamination could not be identified. The presence of the explosive compound could, however, be associated with past activities conducted at S-TEAD. Soil sampling and analysis has not been performed at the CAMDS Facility in the past, nor was it performed as part of this study.

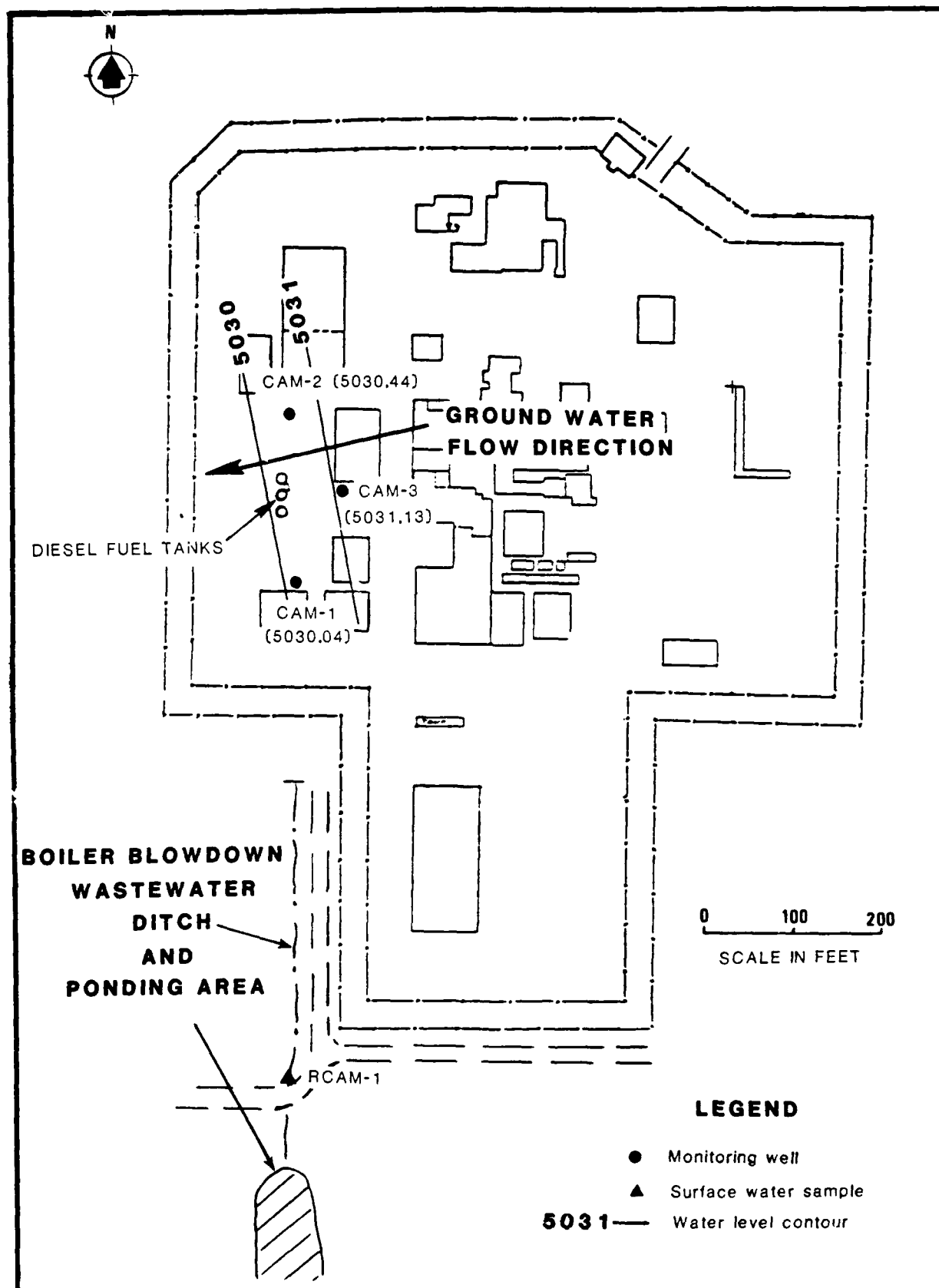


Figure 8-1. Map of S-TEAD CAMDS Facility showing monitoring well and sample locations.

TABLE 8-1 ANALYTICAL RESULTS FOR CAMDS FACILITY MONITORING WELL CAM-3,
S-TEAD, 25 FEBRUARY 1987

Parameter(a)	CAM-3	Utah ^(b) Drinking Water Standards	U.S. EPA ^(c) Water Quality Criteria
VOLATILES			
Benzene	20		.67(d)
Ethylbenzene	6		2,400
SEMI-VOLATILES			
Napthalene	100		
2-Methylnaphthalene	200		
Acenaphthene	40		
DibenzoFuran	10		
Fluorene	20		
Phenanthrene	60		
Bis(2-ethylhexyl)phthalate	2(e)		
Anthracene	3		
AGENT INDICATORS	BCRL		
EXPLOSIVES			
2,4,6-TNT	14.2		
METALS (total)			
Arsenic	400	50	50
Barium	>200	1,000	1,000
Beryllium	1.20		
Chromium	21	50	50
Lead	31	50	50
Silver	0.42	50	50
Sodium (mg/L)	173		20(f)
Zinc (mg/L)	114	5.0(g)	5.0(g)

TABLE 8-1 (Cont.)

Parameter(a)	CAM-3	Utah ^(b) Drinking Water Standards	U.S. EPA ^(c) Water Quality Criteria
INORGANICS			
Chloride (mg/L)	83.5	250(g)	
Fluoride	3,100	2,400	
NO ₂ +NO ₃ Nitrogen	30	10,000(h)	10,000(h)
Orthophosphate	120		
Sulfate (mg/L)	250	1,000	
Gross Alpha (pCi/L)	34±11	15	15
Gross Beta (pCi/L)	36±13	50	50

NOTE: Certified reporting limits (CRLs) are provided in Appendix II-E. The parameters listed were determined according to methods not certified by USATHAMA.

- (a) Units are ug/L unless otherwise noted.
- (b) Utah has adopted Federal standards for inorganics and is in the process of adopting standards for organics.
- (c) Ground water evaluated using Safe Drinking Water Act, MCL's. If MCL's were not available, Clean Water Act, Water Quality Criteria for Human Health were used (U.S. EPA 1985).
- (d) The criterion for all carcinogens is zero; the concentration given corresponds to a carcinogenic risk of 10^{-6} .
- (e) Probably due to laboratory contamination.
- (f) Recommended maximum concentration for people on sodium restricted diets.
- (g) Secondary Standard.
- (h) For nitrate (as N).

Of the eight metals detected in Well CAM-3, only arsenic (400 ppb) exceeded the Federal and State drinking water standard (50 ppb). In previous studies at S-TEAD, arsenic has been detected in the groundwater at high concentrations throughout the Depot and is suspected to result from naturally occurring mineral deposits indigenous to the area. A detailed discussion of the occurrence of arsenic in groundwater at S-TEAD is presented in Section 8.5.

Gross-alpha and gross-beta activity were detected in Well No. CAM-3 at 34 ± 11 and 36 ± 13 pCi/L, respectively. The Federal and Utah primary drinking water standard for gross-alpha and beta are 15 pCi/L and 50 pCi/L, respectively. A discussion of the gross-alpha and gross-beta results for groundwater at S-TEAD is presented in Section 8.5.

8.1.3.2 Boiler Blowdown Runoff

According to Depot personnel, wastewater generated from boiler blowdown and life support system compressors at CAMDS has been sampled. Apparently, these analyses have not revealed any contamination problems, however, no records are available to confirm this. Based on the activities and operations conducted at the facility, and due to the lack of available data, this site was considered to present potential for environmental contamination. Therefore, sampling and analysis of the discharge was conducted during the PA/SI Field Program.

One aqueous sample was collected for determination of explosives, agent indicators, volatile and semi-volatile organics, total phenols, total metals, inorganics, gross-alpha, and gross-beta. Table 8-2 is a summary of all analytical parameters detected in the sample. The sample location (S-RCAM-1) is shown on Figure 8-1.

No volatile organics were detected in the sample; one semi-volatile compound, bis(2-ethylhexyl)phthalate, was detected at 2 ppb. Bis(2-ethylhexyl) phthalate is a compound found in most plastics. The low levels of this compound present in the sample is most likely due to laboratory contamination.

An explosive compound, tetryl, was found at 5.6 ppb. The collected sample contained a great deal of sediment. The presence of tetryl in the sample may be associated with potentially contaminated soil/sediment contained in the sample.

Of the seven metals detected in the sample, none exceeded the Federal or State drinking water standards. Sodium (122,000 ppb) exceeded the U.S. EPA recommended maximum concentration of 20,000 ppb. However, this upper limit is recommended for those people who are on sodium-restrictive diets and does not necessarily apply to everyone. Due to the fact that the boiler blowdown runoff and shallow groundwater is not used as a drinking water source, the sodium content is not a public health concern.

TABLE 8-2 ANALYTICAL RESULTS FOR A WASTEWATER SAMPLE COLLECTED IN
THE VICINITY OF CAMDS, S-TEAD, 25 FEBRUARY 1987

<u>Parameter(a)</u>	<u>S-RCAM-1</u>	<u>U.S. EPA Utah Drinking Water Standard</u>	<u>Water Quality Criteria</u>
VOLATILE	BCRL		
SEMI-VOLATILES			
Bis(2-ethylhexyl) phthalate	2(b)		
AGENT INDICATORS	BCRL		
EXPLOSIVES			
Tetryl	5.6		
METALS			
Arsenic	12.7	50	50
Barium	49	1,000	1,000
Chromium	11.4	50	50
Copper	25	1,000(d)	1,000(d)
Lead	19	50	50
Silver	0.22	50	50
Sodium (mg/L)	122		20(c)
Zinc	47	5,000(d)	5,000(d)
INORGANICS			
Chloride (mg/L)	74	250(d)	
NO ₂ +NO ₃ Nitrogen	840	10,000(e)	10,000(e)
Orthophosphate	3,300		
Sulfate (mg/L)	60	1,000(d)	1,000(d)

(a) Units are ug/L unless otherwise noted.

(b) Probably due to laboratory contamination.

(c) Recommended maximum concentration for people on sodium restricted diets.

(d) Secondary drinking water standard.

(e) For NO₃-Nitrogen.

NOTE: BCRL = Below Certified Reporting Limit (CRL) for all parameters tested. CRLs are provided in Appendix II-E. The parameters listed were determined according to methods not certified by USATHAMA.

Inorganic constituents detected in the sample were chloride, $\text{NO}_2 + \text{NO}_3$ nitrogen, orthophosphate, and sulfate. The Utah and Federal drinking water standard for NO_3 nitrogen is 10,000 ppb, which is considerably greater than the concentration of $\text{NO}_2 + \text{NO}_3$ nitrogen found in the sample (840 ppb).

8.1.4 Environmental and Public Health Impacts

Groundwater

The contaminants of concern in the shallow groundwater table aquifer at the CAMDS Facility as determined from the PA/SI Field Effort were volatiles, semi-volatiles, and explosive compounds. Volatile and semi-volatile compound contamination of the shallow groundwater is related to diesel fuel spills (surface and subsurface) which have occurred at CAMDS. Determining the potential extent of contamination was not within the scope of this study. There are two public health concerns associated with the groundwater contamination found within the CAMDS Facility: (1) potential contamination of supply wells downgradient of the site and (2) health and safety concerns associated with potential seepage of contaminated water and floating product into basements of CAMDS structures.

1. There are no Depot drinking water supply wells located downgradient of CAMDS, and the closest downgradient offsite well is at least 6 miles to the north (this is assuming that groundwater flow from CAMDS exits the southwest corner of S-TEAD and flows north parallel to S-TEAD's western perimeter). In addition, there is no information which indicates the bottom confined shallow aquifer to be in communication with the deep regional aquifer, which occurs at a depth of >500 feet beneath the site. Because of these factors, the immediate risk of potential offsite supply well contamination is considered to be low. The long-term risks cannot be determined from available information.
2. A potential health and safety hazard exists via the seepage of contaminated water and/or floating product into below grade structures (basements) at CAMDS. Several buildings at CAMDS have had problems with groundwater seepage into the basements requiring the use of sump pumps. Employees working in these areas would potentially be exposed to contaminated seepage. In addition, the seepage of product into basements could present a fire hazard. However, for flashing to occur, a sufficient concentration of diesel fuel would have to be present, as well as an ignition source and sufficient oxygen to sustain a fire.

The State of Utah presently does not have regulations in effect regarding subsurface fuel spills. The State Bureau of Solid and Hazardous Waste acts on a case-by-case basis and generally recommends that the local Department of Health be contacted for guidance on cleanup procedures. The proposed Federal underground storage tank regulations probably do not apply to the diesel fuel spills at CAMDS. These proposed regulations

apply to fuel storage tanks which have at least 10 percent of their total tank volume (including product lines) below the ground's surface. To determine if the proposed regulations would apply, the total volume of the product in the pipelines would need to be known.

Surface Water

No naturally occurring perennial surface waterbodies exist in the vicinity of CAMDS. Therefore, the potential for contaminants detected at CAMDS adversely impacting any naturally occurring surface waterbodies downgradient of the site is considered to be extremely low. However, the boiler blowdown wastewater runoff has a potential to adversely impact wildlife which may utilize it as a source of drinking water.

Soils

No sampling or analysis of soils was conducted at the CAMDS facility, however, the results of sampling and analysis of groundwater and of wastewater discharge at the site indicates that surficial and subsurface soils may be contaminated with explosives.

8.2 BOMB WASHOUT POND

8.2.1 Site Description/History

This site is located in the central-east portion of S-TEAD, west of the Old Munition Storage Area No. 2, at an elevation of approximately 5,145 feet above MSL. The Bomb Washout Pond, an unlined evaporation/ percolation pond, received rinsewaters from a bomb renovation operation housed in Building 600. Building 600, formerly located west of the pond, was operated as a high explosive (HE) cluster Bomb Washout Facility from 1940 to 1958. Mustard projectiles, WP, and HC smoke pots were also reportedly renovated in Building 600 (USATHAMA 1979).

8.2.2 Site Characteristics

The Bomb Washout Pond presently consists of a 32 feet x 95 feet x 10-foot deep basin. An overflow ditch, located on the east end of the basin, leads a short distance to the south. The inactive Washout Pond and drainage ditch are overgrown with grasses and tumbleweed. A concrete foundation and concrete settling basin (former Building No. 600) is located approximately 125 feet west of the Washout Pond (Figure 8-2).

The area surrounding the site is flat (0-1 percent slope) with no apparent drainage pathways. Rainfall runoff travels a short distance before infiltrating into the ground. The pond has a potential to collect runoff from the immediate vicinity of the site.

The surficial and subsurface geology of the site consists of Quaternary alluvium and colluvium deposits which possibly extend to a depth of 500 feet or more. The deposits consist of unconsolidated sand, gravel, silt, and clay.

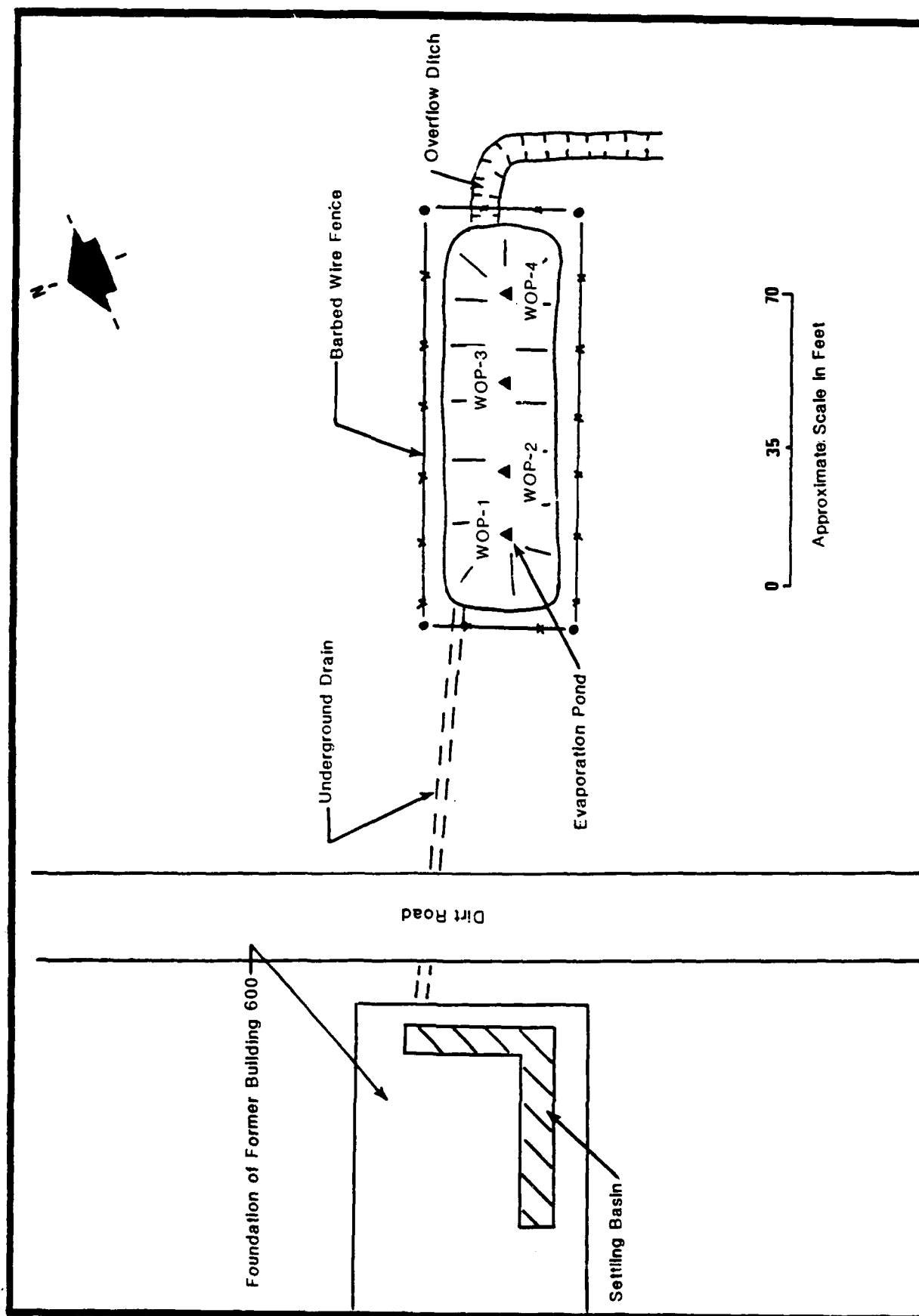


Figure 8-2. Map of S-TEAD Bomb Washout Pond sampling locations.

Monitoring Well S-2 is located approximately 500 feet west-southwest of the Bomb Washout Pond at a similar elevation. The boring log for this well shows a clayey silt extending from ground surface to a depth of 8.5 feet which is underlain by an 11 foot thick layer of gravelly sand (Ertec 1982). Alternating layers of silt, silty gravel, and sand occur to a depth of 86.5 feet (terminal depth of boring). Depth to groundwater, as measured in Well No. S-2 on 18 February 1987, is 56.58 feet BLS. The direction of groundwater movement in the vicinity of the site occurs in a general southerly direction. Well No. S-2 is not located directly downgradient of the site and may not intercept contaminants from the site.

8.2.3 Site Contamination Investigation

There is no record of any previous sampling and analysis having been performed at this site. Because the evaporation/percolation pond received wastewater which potentially contained explosives, sampling of surficial soils within the Bomb Washout Pond and analysis for explosives and nitrate+nitrite nitrogen was performed. Four soil samples (Nos. S-WOP-1, S-WOP-2, S-WOP-3, and S-WOP-4) were collected from the bottom of the basin to a depth of 24 inches, using a stainless steel core sampler (Figure 8-2). The analytical results are summarized in Table 8-3.

The concentration of explosive compounds was below the limit of detection in all samples collected. Nitrate+nitrite nitrogen was detected in all of the soil samples. The significance of the nitrate+nitrite nitrogen levels detected cannot be determined as background concentration levels for soils, at or in the vicinity of S-TEAD, could not be ascertained from available publications, the Tooele District Soil Conservation Service, or from local universities. However, the levels observed at S-WOP-1 (28.7 µg/g) and S-WOP-4 (20.9 µg/g) were generally higher than that observed in surficial soil samples obtained during the PA/SI of N-TEAD (all were <11.1 µg/g) but generally lower than the nitrate+nitrite nitrogen levels observed in the Old TNT Washout Ponds located in N-TEAD. It cannot be determined with an acceptable level of certainty whether the nitrate+nitrite nitrogen levels observed in the S-TEAD Washout Pond are indicative of explosives contamination, the decomposition of naturally occurring organic matter, or from some other anthropogenic source (e.g., laundry effluent).

8.2.4 Public Health and Environmental Concerns

Results of the investigation indicated that the surficial soils remaining within the Bomb Washout Pond were not contaminated with explosives. The PA/SI activities performed do not indicate this site to pose a significant threat to human health or the environment.

8.3 SHOWER/LAUNDRY EFFLUENT HOLDING PONDS

8.3.1 Site Description/History

A former unlined wastewater evaporation/percolation pond is located in the south-central portion of S-TEAD, 500 feet east of abandoned building S-3200. The pond presently consists of a pit, approximately 53 feet by

TABLE 8-3 ANALYTICAL RESULTS FOR SOIL SAMPLES COLLECTED AT THE SHOWER/LAUNDRY EFFLUENT HOLDING POND AND THE BOMB WASHOUT POND, S-TELD, 20 FEBRUARY 1987

Parameter*	Shower/Laundry Effluent Holding Pond	Bomb Washout Pond		
	S-LWOP-1	S-WOP-1	S-WOP-2	S-WOP-3
EXPLOSIVES				
HMX	<9.2	<9.2	<9.2	<9.2
RDX	<6.69	<6.69	<6.69	<6.69
Nitrobenzene	<9.2	<9.2	<9.2	<9.2
1,3-Dinitrobenzene	<0.83	<0.83	<0.83	<0.83
1,3,5-Trinitrobenzene	<0.5	<0.5	<0.5	<0.5
2,4-DNT	<3.4	<3.4	<3.4	<3.4
2,6-DNT	<0.54	<0.54	<0.54	<0.54
2,4,6-TNT	<0.5	<0.5	<0.5	<0.5
INORGANICS				
Nitrate+Nitrite Nitrogen	<11.1	28.7	<11.1	20.9
CA Sample Number	1171	1267	1268	1269
				1270

* Units are ug/g.

NOTE: Certified Reporting Limits (CRL) are provided in Appendix II-E. The parameters listed were determined according to methods not certified by USATHAMA.

27 feet in dimension and 7 feet deep. The site is situated on a small knoll approximately 5,100 feet above msl.

From an inspection of the 1959 EPIC photo, two ponds were present and receiving wastewater from Building S-3200. It is not known if the ponds were connected by overflow pipes. In the 1966 EPIC photo, the northernmost (larger) pond had been closed (filled in) and the southernmost pond was still present. There is no documentation available on operations/activities conducted at Building S-3200. However, based on the site inspection, Building S-3200, appears to have been used as a laundry and/or showering facility with the pond presumably receiving the waste rinse water generated.

8.3.2 Site Characteristics

The existing holding pond (basin) and surrounding area is sparsely covered with grass and sage brush. Site topography slopes 3-5 percent to the east-southeast. There are no apparent drainage pathways in the area. Runoff, in direct response to rainfall, would flow east for a short distance before infiltrating into the ground. Runoff from the area immediately west of the site would drain into the pond (basin) and then infiltrate the ground.

Based on field observations, the site is directly underlain by silty sand. The unconsolidated deposits in the site area are Quarternary Age alluvium and lacustrine deposits consisting of sand, gravel, silt, and clay, which possibly extend to a depth of 500 feet or more.

Groundwater in the vicinity of the site is assumed to be under unconfined conditions. Depth to groundwater is estimated to be between 55 to 65 feet below ground surface. The direction of groundwater movement at the site is to the south-southwest, based on regional data.

8.3.3 Site Contamination Investigation

There is no record of previous sampling and analysis having been performed at this site. Due to lack of information on activities conducted at the site and to the lack of analytical data, one surficial soil sample was collected from the approximate center of the existing pond to evaluate whether the site may have received explosive-contaminated wastewater. The sample was collected with a stainless steel core sampler to a depth of 23 inches.

A summary of results is presented in Table 8-3. No explosive compounds were detected in the surficial soil sample above the limit of detection. Nitrate+nitrite nitrogen, which is a common contaminant in laundry effluent, was <11.1 µg/g.

8.3.4 Public Health and Environmental Concerns

The results of the investigation indicated that surficial soils remaining in the former Shower/Laundry Effluent Holding Pond were not contaminated with explosives. There is no information which indicates that this site presents a significant risk to the environment or public health.

8.4 EXPLOSION CRATERS

8.4.1 Site Location and History

Located in the western portion of the Old Demilitarization Range (southwestern S-TEAD), at approximately 5,040 feet above MSL, are groupings of 285 large craters. According to TEAD personnel, the craters were used for demilitarization of conventional munitions. No information is available on the history or operation of the site, however, the craters were present in the 1974 and 1981 EPIC photos and were observed during the field sampling program conducted in February 1987.

8.4.2 Site Characteristics

The site area consists of a large grouping of 285 explosion craters. Most of the craters are approximately 80-120 feet wide and 30-60 feet deep and have standing water in the bottom, indicating that the groundwater table has been intercepted.

The surficial and subsurface geology of the site area is comprised of lacustrine clay and silt deposits. The area is poorly drained and generally unvegetated.

Two monitoring wells are located in the vicinity of the site: Well No. S-6 is situated at the southwestern corner, downgradient of the craters, and Well No. S-7 is located at the eastern edge of the Old Demilitarization Range (Figure 3-5). Boring logs for Well Nos. S-6 and S-7 indicate the clayey silt deposits which directly underlie the site to range in thickness from 40 feet to 71 feet, respectively (Ertec 1982).

Based on water level measurements obtained on 18 February 1987 across S-TEAD (Table 3-2), groundwater flow at the site appears to be towards the southwest. Depth to water in the vicinity of the site is between 15-25 feet BLS, indicating some of the craters extend below the shallow groundwater table.

8.4.3 Site Contamination Investigation

In order to determine the presence or absence of environmental contamination at this site, an aqueous sample was obtained from two of the explosion craters and analyzed for explosives, chloride, fluoride, bromide, nitrate+nitrite nitrogen, orthophosphate, sulfate, cyanide, gross-alpha and gross-beta, sodium, metals, acid/base/neutral organics, volatile organics, thiodiglycol; and indicator parameters of mustard gas, Agent GB, and Agent VX. Samples were collected using grab sampling methods (i.e., directly filling sample containers). The results of chemical analysis are summarized in Table 8-4. Federal and Utah water quality criteria are also provided for comparative purposes. Groundwater discharge through the base of the craters (base flow) likely sustains the presence of water within them, as they appear to extend below the prevailing groundwater table.

TABLE 8-4 ANALYTICAL RESULTS FOR S-TEAD EXPLOSION CRATERS, 28 FEBRUARY 1987

Parameter(a)	S-EXCR-1	S-EXCR-2	Utah Drinking Water Standards(b)	U.S. EPA Water Quality Criteria
VOLATILE ORGANICS	BCRL	BCRL		
SEMIVOLATILE ORGANICS	BCRL	BCRL		
AGENT INDICATORS	BCRL	BCRL		
EXPLOSIVES	BCRL	BCRL		
METALS				
Arsenic	70	30.0	50	50
Barium	31	65	1,000	1,000
Lead	3.6	1.7	50	50
Silver	>4	2.26	50	50(c)
Sodium (mg/L)	3,300	940	5,000(d)	20(d)
Zinc	20	30		5,000(d)
INORGANICS				
Bromide	300	>2,000	250(d)	10(e)
Chloride (mg/L)	10,000	6,000	10(e)	
NO ₂ +NO ₃ nitrogen (mg/L)	0.065	0.04	1,000	15
Sulfate (mg/L)	3,330	2,300	15	50
Gross Alpha (pCi/L)	<160	<80	50	
Gross Beta (pCi/L)	190±120	130±60		

(a) Units are µg/L unless otherwise noted.

(b) Utah has adopted Federal standards for inorganics and is in the process of adopting standards for organics.

(c) Recommended maximum concentration for people on sodium restricted diets.

(d) Secondary Standard.

(e) For nitrate (as N).

NOTE: BCRL = Below Certified Reporting Limit (CRL) for all parameters tested.

CRLs are provided in Appendix II-E. The parameters listed were determined according to methods not certified by USATHAMA.

Of the compounds detected in the aqueous samples from both craters, only sulfates were detected at levels in excess of Utah Primary Drinking Water Standards. Chloride levels exceeded Utah Secondary Drinking Water Standards, and high levels of sodium were also detected in both samples. Total phenol, volatile organic, semi-volatile organic, explosive, and agent indicator parameters were below Certified Reporting Limits (CRLs).

Several inorganic parameters were detected in the groundwater sample from Well S-6 which is downgradient of the craters. Sulfate, chloride, and sodium occur at high levels (4,450 µg/L, 12,000 µg/L, and 5,700 mg/L, respectively) in Well S-6 (Table 8-5). However, elevated levels of these ions are commonly found in the groundwater of Rush Valley, and generally display an increasing concentration trend toward the valley bottom (Hood et al. 1969). This trend has been attributed to the natural dissolution of these ions as groundwater moves from recharge areas, through the valley fill, to discharge areas (Section 3.2). This general increasing concentration trend toward the valley bottom for these and other inorganic ions is also apparent in the groundwater samples which were obtained from wells throughout S-TEAD (Table 8-5 and Figure 3-5). Furthermore, if it is assumed that the observed levels of these ions in the craters to be "source" levels, their levels would be anticipated to diminish with increased distance from the site due to dilution. Therefore, it cannot be determined with certainty from the available information, whether or not the Craters are responsible, or the degree to which the Craters may or may not be responsible for the elevated levels of sulfate, chloride, and sodium detected. However, available information strongly indicates it to be naturally occurring. Nitrate+nitrite nitrogen concentration in samples EXCR-1 and EXCR-2 were at levels of 65 and 40 µg/L, respectively, which are well below Federal and Utah drinking water standard of 10,000 µg/L.

Results of sampling/analysis of water from the explosion craters did not reveal the presence of explosives. However, one explosive compound, 2,4,-DNT, was detected at 3.3 µg/L in the groundwater sample from S-6 which could be related to the activities conducted at the Old Demilitarization Range. The presence or absence of explosives in any one explosion crater is probably related to the length of time a particular crater was used for demilitarization and how recently demilitarization activities were conducted. Therefore, the absence of explosive compounds in water from one crater does not necessarily indicate that water in other craters are free of explosive contamination.

8.4.4 Public Health and Environmental Concerns

Based on the results of this investigation, the Old Demilitarization Range Explosion Craters which were sampled do not appear to present a significant threat to public health, as the craters are not used as a drinking water source, and there are no drinking water supply wells located in the vicinity of this area. However, the craters have a potential to adversely impact wildlife which may utilize them as a source of drinking water and may be a source of explosive contamination to groundwater.

TABLE 8-5 ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES COLLECTED FROM S-TEAD WELLS, 25-27 FEBRUARY 1987

Parameter(a)	Well Number												Utah(b) Drinking Water Standards	EPA(c) Water Quality Criteria
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-10	S-12	S-14	SBR-1		
VOLATILES														
Toluene	ND	4	ND	3	ND	8	ND	10	ND	ND	ND	7	15,000	
SEMIVOLATILES														
Butyl benzyl phthalate	ND	6 (d)	2 (d)	20 (d)	2 (d)	5 (d)	7 (d)	10 (d)	2 (d)	3 (d)	4 (d)	5 (d)		
Bis(2-ethyl hexyl phthalate	3 (d)	ND	ND	90 (d)	30 (d)	ND	6 (d)	10 (d)	3	ND	ND	7 (d)		
Benzyl alcohol	ND	ND	ND	7	ND	ND	ND	ND	5	ND	ND	ND		
2-methylphenol	ND	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	ND		
Phenol	ND	ND	ND	ND	ND	ND	ND	3	ND	ND	ND	ND	3,500	
AGENT INDICATORS														
BCRL	BCRL	BCRL	BCRL	BCRL	BCRL	BCRL	BCRL	BCRL	BCRL	BCRL	BCRL	BCRL		
EXPLOSIVES														
2,4-DNT	<2.2	<2.2	<2.2	<2.2	<2.2	3.3	<2.2	<2.2	<2.2	<2.2	<2.2	2.5		
2,6 DNT	20.5	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7		
METALS														
Antimony	<7.0	<7.0	<7.0	<7.0	<7.0	7.1	<7.0	<7.0	<7.0	<7.0	15.2	<7.0	146	
Arsenic	260	5.7	30.9	372	154	415	54	14.1	34.2	183	183	50	50	
Barium	32	130	21	140	34	10	103	110	>200	>200	7.9	>200	1,000	
Beryllium	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	1.75	<0.83	<0.83	<0.83		
Cadmium	12	<11.9	<11.9	<11.9	<11.9	<11.9	<11.9	<11.9	<11.9	<11.9	<11.9	<11.9		
Chromium	<10.8	<10.8	<10.8	16	16	<10.8	<10.8	24	88	<10.8	<10.8	31	50	
Copper	<21.3	<21.3	25	29	23	<21.3	90	<21.3	80	24	70	22	1,000 (e)	
Lead	46.9	<1.5	<1.5	3.7	<1.5	3.4	4.9	7.8	27.0	2.7	2.9	7.8	50	
Nickel	<65.2	<65.2	66	<65.2	<65.2	<65.2	<65.2	<65.2	82	<65.2	<65.2	<65.2	15.4	
Silver	0.22	<0.14	0.18	0.40	0.74	>4	1.67	<0.14	0.43	0.43	0.46	<0.14	50	
Sodium (mg/L)	381	26,000	740	1,010	1,000	5,700	2,000	1,800	28	1,600	32,000	29	20 (f)	
Thallium	<1.7	<1.7	2.7	3.1	3.1	<1.7	3.2	<1.7	4.7	2.4	2.8	1.7		
Zinc	<14.3	20	20	160	80	30	120	60	270	90	<14.3	110	5,000 (e)	

TABLE 8-5 (Cont.)

Parameter (a)	Well Number										Utah (b) Drinking Water Standards	EPA (c) Water Quality Criteria	
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-10	S-12			S-14
INORGANICS													
Bromide	628	<244	1,990	2,000	2,800	390	700	<244	<244	1,250	<244	<244	250 (e)
Chloride (mg/L)	350	25	3,200	1,500	2,800	12,000	4,400	49	23	3,000	18,000	1,300	2,400
Fluoride	2,700	<360	1,180	1,400	2,000	1,500	600	<360	600	1,200	500	600	
Nitrate+nitrite	190	1,670	350	636	2,032	110	4,500	2,210	2,000	2,852	640	1,300	10,000 (g)
nitrogen	190	<56.9	70	140	70	180	80	57	<56.9	90	200	<56.9	
Orthophosphate	620	19	900	2,500	1,860	4,450	416	80	40	1,490	1,140	164	1,000
Sulfate (mg/L)	20±11	2.4±1.2	<47	<54	<53	250±150	<65	<6.2	11±6	<55	<370	6.3±2.0	15
Gross Alpha (pCi/L)	25±11	2.1±0.2	<52	98±44	<61	<180	<73	<73	17±6	61±41	410±250	5.2±1.5	50
Gross Beta (pCi/L)													
EA Sample No.	1436	1456	1457	1514	1515	1532	1513	1458	1518	1517	1516	1519	

(a) Units are µg/L (ppb) unless otherwise noted.

(b) Utah has adopted federal drinking water standards for inorganics and is in the process of adopting federal standards for organics.

(c) Groundwater was evaluated using Safe Drinking Water Act, Maximum Contaminant Levels (MCL's). If MCL's were not available, Clean Water Act, Water Quality Criteria for Human Health were used (U.S. EPA 1985).

(d) Probably due to laboratory contamination.

(e) Secondary standard.

(f) Recommended maximum concentration for people on sodium restricted diets.

(g) For Nitrate (as N).

NOTE: BCRL = Below Certified Reporting Limit (CRL) for all parameters tested; ND = Not Detected. CRLs are provided in Appendix II-E. The parameters listed were determined according to methods not certified by USATHAMA.

8.5 SOUTH AREA GROUNDWATER QUALITY

8.5.1 Background Groundwater Quality

All of the existing wells located in S-TEAD are situated downgradient of potentially contaminated sites. Due to the absence of a monitoring well located upgradient of all potentially contaminated areas, a background well (Well No. SBR-1) was installed at the northern perimeter of S-TEAD (Figure 3-5). Well No. S-SBR-1 was sampled for determination of volatile and semi-volatile organics, total phenols, explosives, agent indicators, total metals, inorganics, and gross-alpha and gross-beta radionuclides. Results of analysis are presented in Table 8-5.

Total phenols and agent indicators were not detected above the CRL. Toluene was detected at 7 µg/L, and two semi-volatiles, butyl benzyl phthalate and bis(2-ethylhexyl)phthalate, were detected at 5 and 7 µg/L, respectively. Phthalates were not detected in the trip blank (Table 7-5) or in any of the method or extraction blanks associated with these samples. Therefore, the presence of the phthalate compounds is most likely due to laboratory contamination (phthalates are common components of plastic bottles and gloves typically used in laboratories). One explosive compound, 2,4-DNT, was detected at 2.5 µg/L.

The source of toluene and 2,4-DNT in the groundwater sample is not known. No activities/operations relating to the storage, disposal, or generation of these compounds is known to have occurred upgradient of Well No. SBR-1. However, the general area has reportedly been used as a repository for excess and "unsuitable" soil material (U.S. Army 1982).

8.5.2 Arsenic Contamination

The Environmental Assessment Program conducted at S-TEAD by Ertec (1982) included the installation of 11 monitoring wells to evaluate the potential for contamination at a number of sites, including the Demilitarization Range, the Gravel Pit, the Mustard Holding Area (immediately south of Chemical Ammunition Storage Area No. 2), and the Bomb Washout Facility. One of the major findings of Ertec's investigation was the presence of arsenic in groundwater throughout the Depot.

Levels of arsenic in groundwater samples collected from the monitoring wells during the Ertec investigation (1982) ranged from 8 to 430 µg/L. The Federal and State drinking water standard for arsenic is 50 µg/L. Ertec (1982) also found arsenic in soil and sediment samples at concentrations levels greater than 50 µg/kg. The source of the arsenic contamination was not determined, but its presence throughout the installation indicated that it was probably not related to a single source. Ertec concluded that the arsenic in the groundwater at S-TEAD was most likely the result of naturally occurring arsenic containing minerals.

To confirm the results of the Ertec (1982) study, all existing monitoring wells and newly installed wells (Nos. CAM-3 and SBR-1) were sampled and analyzed for arsenic during the PA/SI Field Program. The analytical results are summarized in Tables 8-1 and 8-5. As is shown on these

tables, arsenic was detected in groundwater samples obtained from all 13 wells at concentration levels ranging from 5.7 µg/L to 415 µg/L. These levels are generally in line with the results obtained by Ertec (1982). Of the 13 wells sampled, 8 wells (S-1, S-4, S-5, S-6, S-7, S-12, S-14, and CAM-3) contained arsenic concentration levels in excess of the Federal and Utah safe drinking water standard of 50 µg/L. These 8 wells are generally located at the valley bottom within the south to southwesternmost aspect of S-TEAD (Figure 8-3).

The detected presence of arsenic in groundwater throughout S-TEAD suggests that its presence is not likely due to a single limited source. In addition, the area directly northeast of S-TEAD between Ophir and Mercur (Figure 1-2) has been extensively mined for arsenic and arsenic associated mineral ores, such as silver and lead (Table 3-1) which further suggest that much of the arsenic contamination may be the result of naturally occurring arsenic.

Arsenic is commonly found in hydrothermal veins with silver and nickel ores and is also associated with barite, cinnabar, realgar, galena (lead), and orpiment (Mason and Berry 1968). Arsenic occurs in various mineral forms, principally as arsenides in sulphide minerals and as arsenates. The most common mineral is arsenopyrite, FeAsS . Arsenic can replace Si^{4+} , Al^{3+} , Fe^{3+} , and Ti^{4+} in rock-forming minerals. Other forms in which it can occur include arsenites, oxides, and alloys (Ure and Berrow 1982).

Little information is available on the weathering behavior of arsenic in rocks and minerals. The oxides As_2O_3 and As_2O_5 are water-soluble but the sulfides, particularly As_2S_3 , are relatively insoluble (Ure and Berrow 1982). Conversion of arsenite to arsenate can occur in alkaline soil conditions and under the influence of ferric oxide (Misra and Tiwari 1963 as cited in Ure and Berrow 1982). With the exception of the alkali-metal arsenates, most metal arsenates are not very soluble (Ure and Berrow 1982).

Arsenic is strongly adsorbed by both iron (Fe) and aluminum (Al) oxides and by amorphous Fe and Al components of soils. Arsenic mobilized by the weathering of rocks and minerals is, therefore, readily taken up by clays and by soils containing iron and aluminium oxides. Ure and Berrow (1982) reported that the average arsenic content for soils, calculated from the recent literature on 1,193 differing soil types, is 11.3 mg/kg. The arsenic content in 195 differing soil types in the United States ranged from 0.1 to 42 mg/kg with an average content of 7.7 mg/kg.

The concentration of arsenate ions at equilibrium in water depends on the cation concentrations and the solubility of the various arsenates that could be precipitated. In the usual pH range of natural water (6.0-8.5), the solubility of calcium or magnesium arsenate is sufficient to permit the content of arsenic in solution to exceed 10,000 µg/L (Hem 1978).

As is shown in Figure 8-3, arsenic concentration levels generally increase in a hydraulically downgradient direction, toward the valley bottom (south to southwesternmost aspect of S-TEAD). This increasing concentration pattern coincides with the concentration of total dissolved

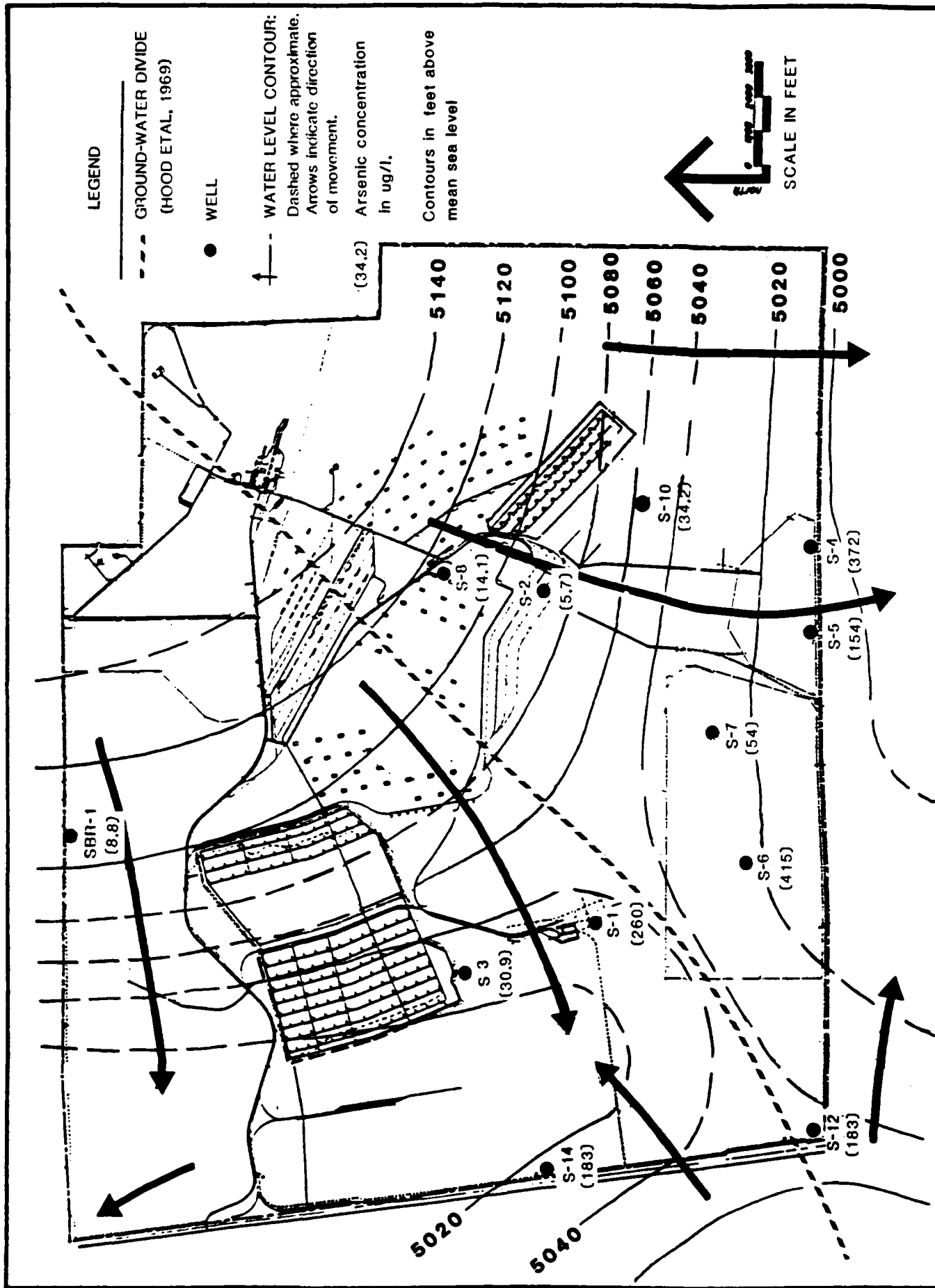


Figure 8-3. Concentration of Arsenic in S-TEAD monitoring wells.

solids for groundwater within Rush Valley (Figure 3-2), which has been attributed to the dissolution of ions as the water moves from recharge areas, through the valley fill, toward discharge points (Hood et al. 1969). A general increasing concentration trend (toward the valley bottom) for sodium, chloride, sulfate, and other inorganic ions is also reflected in S-TEAD wells (Table 8-5). Furthermore, since this part of the depot is a large discharge area, naturally occurring ions, such as arsenic would be continually concentrated at the valley bottom as water is evaporated or evapotranspired.

Water level measurement data obtained from S-TEAD wells during this study also indicates groundwater movement, in the extreme southwest corner of the depot, occurs in a general easterly direction onto the depot (Figure 8-3). Therefore, the elevated levels of arsenic observed in Well Nos. S-12 and S-14 (183 µg/L respectively) potentially have no relationship with activities conducted at S-TEAD, and likely occurs as a result of the natural concentration of arsenic as groundwater migrates onto the Depot from the west.

8.5.3 Gross-Alpha and Gross-Beta Contamination

Gross-alpha and gross-beta radionuclides were detected in groundwater and surface water samples collected at S-TEAD during the Ertec investigation (Ertec 1982). In two surface water samples, concentrations of gross-alpha nuclides exceeded the Federal and State drinking water standard of 15 picocuries per liter (pCi/L). Gross-beta radionuclides were detected in eight of the monitoring well water samples; one sample contained a concentration 46 ± 8 pCi/L, which approaches the Federal and Utah drinking water standard of 50 pCi/L.

To confirm the results of the Ertec (1982) study, all existing monitoring wells and the newly installed wells (except CAM-3 and CAM-2) were sampled for determination of gross-alpha and gross-beta nuclides. Analyses were performed by the Army Environmental Hygiene Agency (AEHA). The analytical results are summarized in Table 8-5.

The gross-alpha detection limits of many samples were greater than the Federal and State drinking water standards. This was due to the high dissolved solids content in the samples interfering with the analysis. Quantifiable levels of gross-alpha activity were reported for 6 of the 13 samples analyzed, with concentrations ranging from 2.4 ± 1.2 pCi/L (Well No. S-2) to 250 ± 150 pCi/L (Well No. S-6). Quantifiable levels of gross-beta radionuclides were observed in 8 of the 13 groundwater samples obtained. Concentrations ranged from 2.1 ± 0.9 (Well No. S-2) to 410 ± 250 pCi/L (Well No. S-14). Similar to the gross-alpha analysis, the detection limits reported for most of the gross-beta samples far exceeded the Federal and State drinking water standards of 50 pCi/L due to interference by the high dissolved solids content.

Radioactivity in natural water systems may be broadly categorized as naturally occurring or man-made. The property of radioactivity is the emission of radiant energy by the nuclei of certain atoms which disintegrate. This energy is given off in the form of alpha, beta, and gamma radiation. The alpha particles are positively charged helium nuclei.

Beta rays are electrons, and gamma rays are electromagnetic waves of very short wavelength. In groundwater, radioactivity occurs as the result of the presence of isotopes. For the most part, radioactive materials are dissolved ions, but a small amount of activity can be imparted by tritium (H-3) replacing normal hydrogen in some of the water molecules.

There are three naturally occurring isotopes, of high atomic weight, which form the starting point for a series of disintegrations which produce radioactivity. The disintegrations proceed in steps, each producing a different radioactive nuclide, until finally a non-radioactive isotope of lead is produced. These series begin with U-238 (uranium series), Th-232 (thorium series), and U-235 (actinium series). Members of the first two series are responsible for most of the natural radioactivity found in groundwater. The actinium series is not very important as a source of radioactivity in groundwater because natural uranium contains only a very small amount of the U-235 isotope. A few other naturally occurring isotopes are radioactive, for example, K-40 and Rb-87, but they constitute relatively small proportions of naturally occurring potassium and rubidium (Hem 1978). However, natural radioactivity in soils is reportedly due mainly to the presence of these isotopes and the disintegration of uranium and thorium (Ure and Berrow 1982).

The alpha activity of groundwater is essentially the result of disintegration of nuclides in the naturally occurring radioactive series of elements. Isotopes of radium and radon are the most important alpha emitters. Beta and gamma activity also is evidenced by some of the members of these series, and also is characteristic of the naturally occurring isotopes K-40 and Rb-87. Many of the products of nuclear fission are strong beta emitters. Sr-89, Sr-90, I-131, Pu-239, Ca-45, and Co-60 are among the artificially produced fission products having very high activity. Although these are absent from natural waters, they may be added in waste material from nuclear fission and result in the contamination of natural waters. However, there has been no evidence of the use, storage, disposal, etc. of any radioactive materials in the South Area of TEAD.

Natural uranium is composed of several isotopes of which U-238 predominates. As previously mentioned, this is the starting point in a radioactive decay series which ends with the lead isotope Pb-206. Uranium is widely distributed in igneous rocks. It is present in largest amounts in sodic granites and decreases in amount as the proportion of ferromagnesian minerals increases, reaching a minimum in ultrabasic rocks (Faul 1954). In sedimentary rocks, uranium may occur as adsorbed ions or be included in the cementing material of sandstones. It is also deposited where organic matter causes locally favorable conditions in sediments (Hem 1978). As was indicated in Section 3.0, the aforementioned rock types are common to the mountains and alluvium of Rush Valley. Uranium is commonly found in most natural waters at concentrations less than 10 pCi/L (Hem 1978). Radium-226, an alpha emitter and disintegration product of U-238, is distributed widely in the United States and is frequently present in groundwater of the Rocky Mountain States. In a few cases, radium-228, a beta emitter which results from the disintegration of radium-226, is also present (U.S. EPA 1976). Radium occurs naturally in most waters, generally at a concentration of less than 1 pCi/L.

The widespread occurrence of the gross-alpha and gross-beta activity detected in S-TEAD wells, and the lack of known sources of radioactive materials at S-TEAD, strongly suggests its presence to be naturally occurring. Furthermore, samples obtained from the wells located toward the valley bottom generally show higher gross alpha and beta concentration levels than those located closer to the valley edges. Other inorganics, such as sodium, chloride, and sulfate (Table 8-5) and total dissolved solids (Figure 3-2) also show a similar trend. This suggests that the gross alpha and beta activity measured in the S-TEAD wells may also be becoming concentrated, as groundwater moves naturally toward the valley bottom, for reasons previously discussed in Section 8.5.2.

Because there are no downgradient water supply wells which could potentially be impacted, no immediate risk to the health or welfare of the public appears to exist from the elevated gross-alpha and gross-beta activity measured in S-TEAD wells.

8.5.4 Agent Breakdown Products

S TEAD has been used extensively since the 1940s for the storage, renovation, and disposal of chemical agent materials and munitions. The environmental investigation conducted by Ertec (1982) did not evaluate the potential for chemical agent contamination of groundwater. However, due to the extensive and extended use of chemical agents at S-TEAD, sampling of groundwater from all existing and newly installed wells was conducted for determination of agent breakdown products (indicator parameters of chemical agents). These parameters included thiodiglycol, isopropylamine, organosulfur compounds, and methylphosphonates.

Results of the analyses showed that concentrations of all breakdown products were below the CRL for all samples. These results indicated that potential sources of chemical agent contamination have not adversely impacted groundwater quality at S-TEAD. It is possible that potential contamination of groundwater may not have been intercepted by the existing monitoring network at S-TEAD. The most significant potential sources of chemical agent contamination are believed to be the Gravel Pit (located immediately south of Chemical Ammunition Storage Area No. 10), the Chemical Demilitarization Range disposal pits, and the Mustard Holding area south of Chemical Ammunition Storage Area No. 2.

8.5.5 Organic Parameters

Volatile Compounds

In general, industrial and maintenance activities involving the use of organic solvents has not been practiced at S-TEAD. Existing monitoring wells were sampled during the Ertec (1982) investigation for volatile and semi-volatile compounds. The only parameter detected was a semi-volatile compound, diethylphthalate, in Well No. S-8. To confirm the result of the Ertec study, sampling of groundwater from all existing and newly installed wells for determination of volatile and semi-volatile organic parameters was conducted during the field program.

Toluene was the only volatile organic compound detected. Toluene was found in Well Nos. S-2, S-3, S-6, S-8, and SBR-1 at concentrations of 4, 3, 8, 10, and 7 µg/L, respectively. The source of the toluene contamination is not known. The available records for S-TEAD do not indicate that activities/operations conducted upgradient of these monitoring wells would contribute to this type of contamination.

The presence of toluene in groundwater at the levels detected does not present an immediate risk to the environment or public health. The EPA Water Quality Criteria for toluene is 15,000 µg/L. There are no drinking water supply wells located downgradient of these monitoring points. Furthermore, sampling and analysis of monitoring wells located on the southern and western perimeters of S-TEAD did not indicate that migration of contaminants off-post has occurred.

Semi-Volatile Compounds

Five semi-volatile compounds were detected in the groundwater at S-TEAD: butyl benzyl phthalate, bis(2-ethylhexyl) phthalate, phenol, benzyl alcohol, and 2-methyl phenol. Results are summarized in Table 8-5. The presence of the phthalate compounds is most likely due to laboratory contamination. Phthalates are common constituents of plastics, and contact of the sample with plastic materials would most likely result in the low level contamination detected in these samples.

Phenol was detected in Well No. S-8 at 3 µg/L. Benzyl alcohol was detected in Well Nos. S-4 and S-10 at 7 and 10 µg/L, respectively. Levels of 2-methyl phenol were present in Well No. S-7 at 5 µg/L. The source of these semi-volatile compounds is not known and based on available records, there is no indication of any potential contaminant sources located upgradient of these monitoring points.

The environmental and public health impact of the semi-volatile organic contamination is not considered to be significant. There are no drinking water supply wells located immediately downgradient of the contaminated monitoring wells.

8.5.6 Inorganic Parameters

Sampling of groundwater from all existing and newly installed wells for determination of total metals, bromide, chloride, fluoride, total cyanide, nitrate+nitrite nitrogen, orthophosphate, and sulfate was performed during the field program. Table 8-5 summarizes the analytical results, which are discussed below.

Metals

Chromium was detected in the sample from Well No. S-10 at a concentration of 88 µg/L. The Federal and Utah drinking water standard for chromium is 50 µg/L. Note, however, that analysis for total metals was performed. The dissolved chromium concentration level would likely be lower and potentially be less than the Federal and Utah drinking water standard.

The metal concentrations in all other samples, with the exception of arsenic, were below applicable Federal and State drinking water standards (Table 8-5).

The source of chromium in the groundwater sample No. S-10 is not known. The presence of chromium in Well No. S-10 does not present any immediate environmental or public health risk. There are no drinking water supply wells located immediately downgradient of this monitoring point. Furthermore, chromium was not detected in any of the monitoring wells located on the southern and western perimeters of S-TEAD, indicating that contamination has not migrated off-post.

Other Inorganic Parameters

In addition to analysis of metals, all groundwater samples obtained from S-TEAD were analyzed for bromide, chloride, total cyanide, fluoride, nitrate+nitrite nitrogen, orthophosphate, and sulfate (Table 8-5).

Cyanide was not detected above the CRL in any of the samples. Concentrations of nitrate+nitrite nitrogen from the monitoring well samples ranged from .11 to 4.5 mg/L, which is well below the drinking water standard of 10 mg/L for nitrate-nitrogen.

The Utah secondary drinking water standard for chloride (250 µg/L) was exceeded in 10 of the 13 samples; concentrations ranged from 23 to 18,000 µg/L (average = 3,586 µg/L). Sulfate concentrations in 5 of the 13 samples exceeded the Utah primary drinking water standard (1,000 µg/L); concentrations ranged from 19 to 4,450 µg/L (average = 1,071 µg/L). Fluoride was detected in 10 of the 13 wells sampled. Concentrations ranged from 0.5 to 3.1 mg/L with an average concentration of 1.54 mg/L. The Utah drinking water standard for fluoride is 1.2-2.4 mg/L, and is determined based on the annual average maximum daily air temperature. Utah's maximum allowable fluoride concentration (2.4 mg/L) was exceeded in two of the samples (CAM-3 and S-1). In general, the concentration level of the inorganic compounds detected was highest in samples obtained from wells located along the valley bottom. A general increasing concentration trend from the valley edges (hydraulically upgradient well locations within S-TEAD) to the valley bottom (hydraulically downgradient well locations) is also apparent, the widespread presence and occurrence of the inorganic compounds at S-TEAD strongly suggests the elevated levels detected to be a naturally occurring phenomenon (for reasons previously presented in Sections 8.4 and 8.5). Individual sites cannot be adequately evaluated because of the absence of both upgradient and downgradient monitoring wells in their close proximity.

The elevated levels of inorganic compounds detected in groundwater at S-TEAD does not present a significant public health risk as there are no drinking water supply wells downgradient of contaminated monitoring points.

9. CONCLUSIONS

The major findings and conclusions of the installation PA/SI conducted at S-TEAD are outlined below.

9.1 PRELIMINARY SITE ASSESSMENTS

Based on a review of available records, personnel interviews, and an onsite inspection:

- . The following sites were considered to have a low potential for environmental contamination: (1) Sewage Lagoon, (2) South Area Lab, (3) Munitions Storage Areas 9 and 10, (4) Old Munitions Storage Area 2, (5) Warehouse C4002 Demilitarization Pit, (6) Active Sanitary Landfill, and (7) Abandoned Sanitary Landfill.
- . The release of contaminants to the environment has resulted, or has a high potential to occur, at the following sites: (1) Mustard Holding Area, (2) Chemical Demilitarization Range Disposal Pits, (3) Windrow Area, (4) Gravel Pit, and (5) the Burial Pit. Sampling and analysis of soil and/or groundwater would be required to confirm the potential presence or absence of contamination at these sites. The existing monitoring well network is not considered adequate to assess the potential for groundwater contamination which may or may not be emanating from these sites.

9.2 PRELIMINARY INVESTIGATIONS

9.2.1 CAMDS Facility

- . Surface and subsurface diesel fuel spills in the vicinity of the tank field have resulted in groundwater contamination. Floating product was observed in Well Nos. CAM-1 and CAM-2, and chemical components of diesel fuel were detected in Well No. CAM-3.
- . A potential exists for floating product and/or diesel fuel contaminated groundwater seepage to occur in below-grade structures at the CAMDS Facility. This could result in a potential fire hazard and/or health hazard, via hazardous component exposure, to employees working in these areas.
- . Explosives were detected in groundwater samples obtained from Well Nos. CAM-3 and S-1 and in the boiler blowdown discharge. The results suggest that soils in the CAMDS Facility area may be contaminated with explosives.

9.2.2 Bomb Washout Pond

- . Analysis of surficial soil samples obtained from the Bomb Washout Pond did not show the presence of any explosives above the Certified Reporting Limit.

9.2.3 Shower/Laundry Effluent Holding Ponds

- . Analysis of a surficial soil sample obtained from the existing holding pond at this site did not reveal any explosive contamination. There is no information which indicates that the activities at this site have resulted in environmental contamination.

9.2.4 Explosion Craters

- . Analysis of surface water samples obtained from two explosion craters located in the Old Demilitarization Range did not reveal any contamination which could be attributed to the activities conducted at this site.

9.2.5 South Area Groundwater Quality

- . Toluene was the only volatile organic compound detected in groundwater, and was found in 5 of the 13 wells sampled (including upgradient Well SBR-1) at concentrations ranging from 3 to 10 µg/L. The source of the toluene contamination found is not known, as there is no documentation indicating that activities/operations practiced at S-TEAD would contribute this type of contamination. The level of toluene contamination found in the groundwater is not considered to present a significant environmental or public health risk.
- . Five semi-volatile compounds were detected in groundwater samples: butyl benzyl phthalate, bis(2-ethylhexyl)phthalate, phenol, butyl benzyl alcohol, and 2-methyl phenol. The first two compounds are common components of plastics, and their presence is most likely due to laboratory contamination. The source of the other three semi-volatiles, which range in concentrations from 3 to 7 µg/L, is not known and could not be determined from the available database. The levels of semi-volatile compounds detected in the groundwater samples are not considered to present a significant environmental or public health risk.
- . Chemical agent breakdown products were not detected in any of the groundwater samples.
- . Explosive compounds were found above certified reporting levels in 4 groundwater samples. 2,4-DNT was detected in the samples from Well Nos. SBR-1 and S-6 at concentrations of 2.5 µg/L and 3.3 µg/L, respectively. 2,4,6-TNT was detected in the sample from CAM-3 at a concentration of 14.2 µg/L and 2,6-DNT was detected at a level of 20.5 µg/L in a sample

obtained from Well S-1. The source of the explosive compound contamination detected in upgradient Well SBR-1 is not known and could not be determined from the available database. The explosive contamination found in S-6 is likely due to the demilitarization activities conducted in the Old Demilitarization Range. Contaminated soil is a possible source of the explosive detected in CAM-3 and S-1.

- . Chromium was detected in a groundwater sample obtained from Well No. S-10 at a concentration of 88 $\mu\text{g/L}$. The Federal and Utah drinking water standard for chromium is 50 $\mu\text{g/L}$. However, total metals analysis was performed and the concentration of dissolved metals would be anticipated to be less. The source of the elevated chromium level detected in this well is not known and could not be determined from the available database.
- . Concentrations of nitrate+nitrite nitrogen were below the Federal and State drinking water standards for all groundwater samples.
- . Arsenic, sodium, chloride, sulfate, and gross alpha and beta radionuclide activity were detected in all groundwater samples. Applicable Federal and Utah drinking water standards for these constituents were often exceeded in samples obtained from wells which are generally located toward the valley bottom (south-southwest portion of S-TEAD). A general increasing concentration trend toward the valley bottom is also apparent. Available information indicates that much of the widespread presence and occurrence of these constituents in groundwater at S-TEAD may be due to naturally occurring sources.
- . Whether an individual site, or the degree to which an individual site, may or may not be contributing to the contamination of groundwater at S-TEAD could not be determined due to the natural occurrence of many of the constituents of concern and the absence of both upgradient and downgradient monitoring wells in close proximity of individual sites. The data obtained during this investigation provide for a preliminary assessment of the overall presence and extent of groundwater contamination at S-TEAD only.
- . Based on the present monitoring well network and the preliminary data generated during this investigation, the quality of groundwater at S-TEAD is not considered to present an immediate risk to the health or welfare of the public as there is no indication that off-Depot contaminant migration has occurred, and there are no downgradient water supply wells in the immediate vicinity of S-TEAD which could be impacted. However, contamination may affect the future use of the groundwater in this area.

10. RECOMMENDATIONS

Based on the findings of the S-TEAD PA/SI and previous environmental studies, the following recommendations are made.

- . Determine the extent of diesel fuel contamination at the CAMDS Facility by performing soil borings and installing additional monitoring wells west of the diesel fuel storage tank area. Obtain groundwater and subsoil samples for chemical analysis. Analysis should include total petroleum hydrocarbons (for plume delineation) and explosives, in order to verify the presence and determine the source/extent (isolate, if possible) of explosives contamination.
- . Visually inspect and survey basements of below grade structures in the western portion of the CAMDS Facility with an Organic Vapor Analyzer (OVA) and Combustible Gas Indicator for the presence of diesel fuel. Inspect sumps for diesel fuel product and obtain samples for chemical analysis. Analysis should include total petroleum hydrocarbons and volatile and base/neutral organics.
- . Collect a sediment-free aqueous sample of the boiler blowdown discharge at the CAMDS Facility prior to where it enters the drainage ditch, and aqueous and sediment samples along the drainage ditch and ponding area, to determine the source and extent of potential explosives contamination.
- . Determine the presence/absence of potential contamination in the former Mustard Holding Area by obtaining soil samples for thiodiglycol (a mustard breakdown product) analysis.
- . Install additional monitoring wells in the eastern-southeastern, western-southwestern, and northwestern perimeter area of S-TEAD to determine the presence of contamination, the potential for offsite and off-depot migration of contaminants, if found, and to provide data to better define the direction of groundwater flow in these areas.
- . Monitoring well installation and groundwater sampling downgradient of Windrow Area, Gravel Pit, Burial Pit, Mustard Holding Area, and Chemical Demilitarization Range is recommended, however, due to unexploded ordnance (both chemical and conventional) in these regions, this is deemed unsafe and not practical. As an alternative, the monitoring wells recommended to be installed near the perimeter of S-TEAD in the southwest, southeast, and west should be placed downgradient and as close to these sites as can be safely performed.

- . The additional and existing monitoring S-TEAD wells should be at a minimum monitored for priority pollutants, explosives, inorganics, and agent breakdown products. If contaminants (i.e., toluene, semi-volatiles, and chromium) remain to be detected, the areas of contamination should be evaluated further to determine their source.
- . Conduct aquifer testing on selected wells to determine the rate of groundwater flow, such that travel times and distances for groundwater movement from individual sites and S-TEAD as a whole can be evaluated.

REFERENCES

- Army Environmental Hygiene Agency (AEHA). 1986. Ground-Water Consultation No. 38-26-1364-86, Evaluation of Solid Waste Management Units, Tooele Army Depot, South Area, Tooele, Utah, 28 July - 1 August.
- EA Engineering, Science, and Technology, Inc. 1985. Plan of Accomplishment/Resource Plan for Installation Reassessments. Prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Grounds, Maryland. October.
- EA. 1986. Final Field Sampling/Health and Safety Plan, Tooele Army Depot, Utah. Prepared for the U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Edgewood, Maryland.
- Ertec. 1982. Assessment of Environmental Contamination Exploratory Stage, Tooele Army Depot, Utah. Prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland. Contract No. DAAAG49-81-C-0192.
- Everitt, R.L. and B.N. Kaliser. 1980. Geology for Assessment of Seismic Risk in Tooele and Rush Valleys, Tooele County, Utah. State of Utah, Department of Natural Resources. Special Study No. 51.
- Faul, H., Ed. 1954. Nuclear Geology: John Wiley and Sons, New York, New York.
- Flam, K. 1988. Engineer, U.S. Army Toxic and Hazardous Materials Agency, Personal Communication with T. Porter, EA Science and Technology. September.
- Gates, J.S. 1965. Re-evaluation of Ground-Water Resources of Tooele Valley, Utah. Utah State Engineer Technical Publication No. 12.
- Hem, J.D. 1978. Study and Interpretation of the Chemical Characteristics of Natural Water. 2nd Edition. U.S. Geologic Survey Water Supply Paper No. 1473.
- Hood, J.W., D. Price, and K.M. Waddel. 1969. Hydrologic Reconnaissance of Rush Valley, Tooele County, Utah. Utah Department of Natural Resources Technical Publication No. 23.
- Mason, B. and L.G. Berry. 1968. Elements of Mineralogy. W.H. Freeman and Company. San Francisco, California.
- Moore, W.J and M.L. Sorensen. 1979. Preliminary Geologic Map of the Tooele Quadrangle, Utah: U.S. Geological Survey Open File Map, 1:250,000 scale.
- R&M Consultants, Inc. 1984. Geotechnical Investigations and Permanent Ground Water Drain System Design, CAMDS Site, Tooele Army Depot, Tooele County, Utah. Salt Lake City, Utah. September.
- Razem, A.C. and J.I. Steiger. 1981. Ground-Water Conditions in Tooele Valley, Utah, 1976-1978. Utah Department of Natural Resources Technical Publication No. 69.

REFERENCES (Cont.)

- Tooele Army Depot. 1981. Memorandum for Record, Subject: Results of IR Site Reconnaissance, 11 March. 16 March.
- Tooele Army Depot. 1985a. A Study of Environmental Balance. Tooele Army Depot, Tooele, Utah. March.
- Tooele Army Depot. 1985b. Analytical/Environmental Assessment Report. Facilities Engineering Division, Tooele Army Depot, Tooele, Utah. November.
- Ure, A.M. and M.L. Berrow. 1982. The Elemental Constituents of Soils. In Environmental Chemistry, Volume 2. Royal Society of Chemistry, Burlington House, London.
- USATHAMA. 1979. Installation Assessment of Tooele Army Depot, Report No. 141. U.S. Army, Aberdeen Proving Ground, Maryland.
- USATHAMA. 1983. Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports. Aberdeen Proving Grounds, Maryland. May.
- U.S. Army. 1982. Installation Environmental Assessment, Tooele Army Depot, North and South Area, Tooele Utah. Prepared by Inland Pacific Engineering Company, Spokane, Washington for Headquarters, U.S. Army Depot System Command.
- U.S. Department of Commerce, Bureau of Census and Housing. 1981. 1980 Census of Population. March.
- U.S. Environmental Protection Agency (U.S. EPA). 1976. National Interim Primary Drinking Water Standards.
- U.S. EPA. 1985. Installation Assessment, Tooele Army Depot (South Area), Utah. Environmental Photo Interpretation Center, Environmental Monitoring Systems Laboratory, Warrenton, Virginia. TS-PIC-0066.
- Utah Geological and Mineral Survey. 1980. Special Studies 51, Geology for Assessment of Seismic Risk in the Tooele and Rush Valleys, Tooele County, Utah. Plate IV. March.